Making Your Projects Look Great!

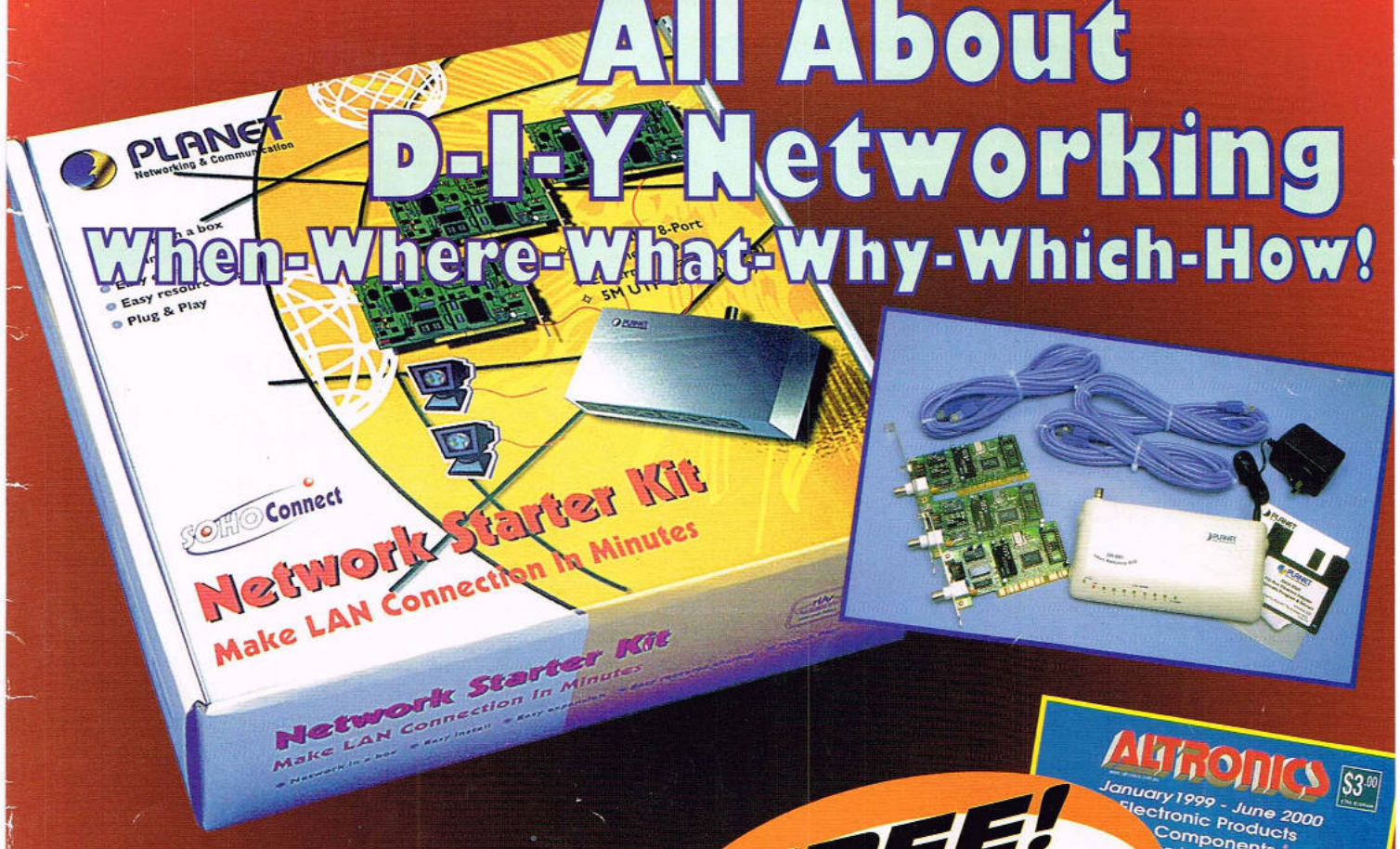
SILICON CHIP

FEBRUARY 1999
$5.50* NZ$6.50 INCL GST
ISSN 1030-2662
02
PRINT POST APPROVED - PP255003/01272
9 771030 266001
www.siliconchip.com.au

PROJECTS TO BUILD - SERVICING - COMPUTERS - VINTAGE RADIO - RADIO CONTROL

All About D-I-Y Networking

When-Where-What-Why-Which-How!



FREE! NEW 244 PAGE ALTRONICS 1999 CATALOG *AUST ONLY

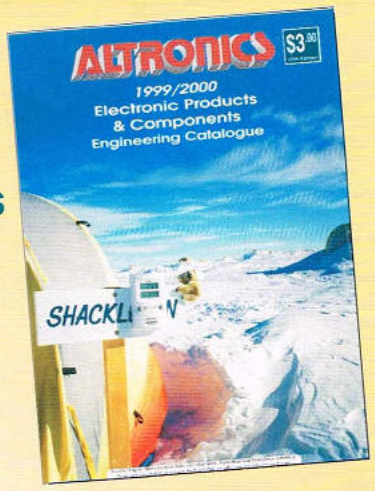
TEST GEAR TO BUILD:

Audio Oscillator
Capacitance Meter
Remote Control Tester

ALTRONICS

Our Largest Catalogue EVER, 244 pages crammed full of exciting new products!

1999/2000 Electronic Engineering Catalogue



The ALTRONICS 1999/2000 Catalogue is *FREE* with the February issue of Silicon Chip Magazine, or Phone 1-800 999 007 before 30th April 1999 for your free copy! • 244 pages • Hundreds of exciting new products for 1999 • Expanded product range, specifications and data. ***And for the very quick...***

To celebrate the release of our finest ever catalogue, we are offering these excellent products at bargain prices!

Illuminated Magnifying Lamp

"Fantastic for servicing PCB's and identifying micro miniature components"

Super Bonus
FREE, *with every A 0970 purchased this month,* receive an A 0960 **Valued at $11.50**

The magnifying head is easily set to the desired position on it's spring-loaded arm assembly. Simply clamps to your workbench or desk.

As you grow older, it's inevitable that your eyesight is going to falter. Maybe you're already finding it difficult to read those tiny zeners or find that small solder bridge on your PCB. If so, this magnificent 3 dioptre illuminated magnifier could be the solution for you. Uses are not only limited to electronics, of course. It's ideally suited to stamp and coin collectors, model makers, embroiderer, jewellers and the like.

NEW!

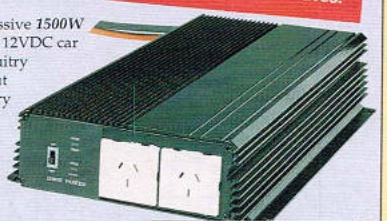
A 0970 Normally $149, *NOW ONLY* **$139**

No workbench should be without one!

1500W Switchmode 12V / 240V Inverter

Massive 1500 Watts Output!
Ideal for Remote Home Power Systems. Will Power a wide range of appliances, including Fluoro Lights & Microwaves.

This inverter provides up to a massive *1500W* of 240V power from a heavy duty 12VDC car or truck battery. Switchmode circuitry eliminates bulky and heavy output transformers, making this unit very lightweight compared to similar inverters. It's suitable for a wide range of applications such as remote homes, sail and power boats, building or mine sites, off road vehicles, caravans, farms etc.



Features: • Over temperature & overload shutdown • Auto fan cooling • Low battery warning & shutdown • Heavy duty leads • Twin outlets • Weighs only 3.6kgs

SUPER SPECIAL! ***SAVE a HUGE $200!***

M 8140A Normally $995, NOW ONLY **$795**

A Bench Power Supply for Life!

0-30V 2.5A Power Supply

A lab supply with a main output rail adjustable from 0 to 30V, at up to 2.5A.
Features: • Separate controls for voltage and current limiting • Fixed 12V and 5V output rails, at up to 1A peak • Precision digital LCD Voltage and Current Meters for fine adjustment for use in research and development labs, instrumentation testing, digital circuits, etc.

Precision Digital LCD Volt and Current meters accurate to within 0.5%!

M 8200 Was $229, NOW **$189**

5 Sector DSC Alarm System with Auto Dialler

This system is the same type used by commercial alarm companies.

Improve the security of your home or business with this micro-processor controlled alarm, & get $150 worth of accessories FREE!!

This alarm can be configured to automatically dial two preset numbers in the event of an alarm. The entire system is controlled and programmed via a keypad.

Features: • master code and three adjustable user codes • monitor function which tests battery backup and mains failure • four sectors plus 24Hr zone • once triggered the alarm has the option of a silent alarm plus dial out • quick arming option • zone bypassing for sectors which are false triggering • door chime mode for entry/exit paths • battery backup • home or away operation • comprehensive instructions • 12 months warranty

Super Bonus Deal!
Purchase a S 5490 5 Sector Alarm system during the Sale, and we'll supply ***$150*** worth of accessories ***FREE!!!*** Bonus package includes W 2346 50m of 4 Core Sec Cable, M 9710 Plugpack, S 5075 Backup battery, S 6130 Siren, S 5445 Blue Strobe, 2 Large alarm stickers and 4 window stickers!

S 5490 **$299**

Mini Drill Set

NEW MODEL HOUSED IN A TOUGH PLASTIC CARRY CASE!

One of the most powerful mini drills we've seen! Great for drilling PCBs, polishing, engraving, etc

A fantastic addition to your tool kit, this powerful mini drill kit includes DC plugpack adaptor, four grinding stone bits, a cutting disc, four chucks (0.5, 1, 1.5, 2.4 and 3mm) and 5 PCB drills (0.5, 0.8, 1, 1.2 and 1.5mm). It's lightweight yet torquey enough to handle some tough jobs! Great for drilling and trimming PCBs, engraving your valuables, model making, polishing gems or jewellery, custom panel work etc.

SAVE OVER 30%

T 2301 Normally $69, NOW **$45**

Sorry, not available from Dealers at this price

PIR Detector to suit

Famous Australian Made NESS Quantum PIR
Incorporates Pulse Count Triggering

Features: • Small size • User selectable Pulse Count On-Off • Dual Element Pyroelectric Sensor • Surface or corner mounting • N.C. Alarm contacts in standby condition • Tamper switch • Adjustable Beam Height Angle • Single pulse or triple count • Exceptional RFI and ESD immunity

S 5305 Last Year $49, NOW $39, this month only with the above system. Buy two for ONLY $65!

2 Year Warranty

1000's sold, and not ONE unit returned! Be wary of cheaper imported products which could cause false triggering and compromise the integrity of your security system

ALTRONICS

174 Roe St., Perth W.A. 6000 www.altronics.com.au
Phone: (08) 9328 1599 **Fax:** (08) 9328 3487
MAIL ORDERS: C/- P.O. Box 8350,
Perth Business Centre, W.A. 6849

Mail Order Line: 1-800 999 007

Contents

SILICON CHIP
Vol.12, No.2; February 1999

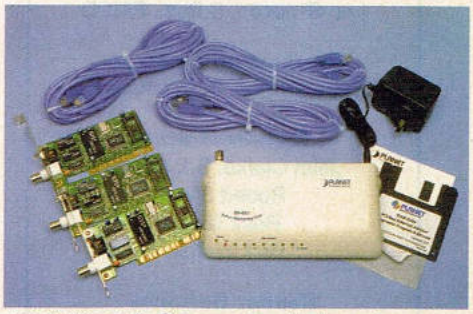
FEATURES

4 Installing A Computer Network
Network types, hubs, switches and routers – by Bob Dyball & Greg Swain

18 Traction Control Systems
Using electronics to make your car corner better – by Julian Edgar

34 Making Front Panels For Your Projects
Producing professional project panels for peanuts – by Ross Tester

80 Electric Lighting; Pt.11
High intensity discharge lighting for cars – by Julian Edgar



Installing A Computer Network – Page 4.

PROJECTS TO BUILD

24 Low Distortion Audio Signal Generator; Pt.1
Produces both sine & square waves and has a 4-digit frequency readout – by John Clarke

40 Command Control Decoder For Model Railways
New circuit uses fewer parts and feeds smooth DC to the loco motors – by Cam Fletcher

66 Build A Digital Capacitance Meter
It measures values up to 2µF and displays the results on an LCD meter – by Rick Walters

73 A Remote Control Tester
Simple unit for checking recalcitrant remote controls – by Leo Simpson

84 LEDS Have Fun
You can build it has a dice, a chaser, a doorbell, a ladder game, a timer or just to provide a random display – by Leo Simpson

Low Distortion Audio Signal Generator – Page 24.

SPECIAL COLUMNS

56 Serviceman's Log
The set that languished and died – by the TV Serviceman

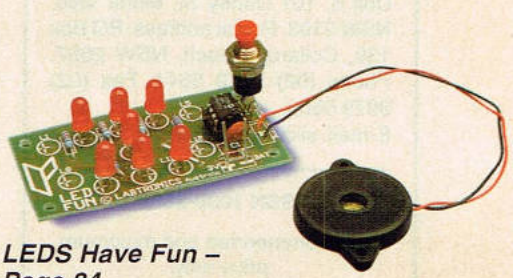
60 Radio Control
Model R/C helicopters; Pt.2 – by Bob Young

87 Vintage Radio
The classic Atwater Kent Model 32 – by Rodney Champness

Build A Digital Capacitance Meter – Page 66.

DEPARTMENTS

2 Publisher's Letter
33 Order Form
53 Product Showcase
76 Circuit Notebook
90 Ask Silicon Chip
93 Notes & Errata
94 Market Centre
96 Advertising Index



LEDS Have Fun – Page 84

SILICON CHIP
www.siliconchip.com.au

Publisher & Editor-in-Chief
Leo Simpson, B.Bus., FAICD

Production Manager
Greg Swain, B.Sc.(Hons.)

Technical Staff
John Clarke, B.E.(Elec.)
Robert Flynn
Ross Tester
Rick Walters

Reader Services
Ann Jenkinson

Advertising Enquiries
Leo Simpson
Phone (02) 9979 5644
Fax (02) 9979 6503

Regular Contributors
Brendan Akhurst
Rodney Champness
Garry Cratt, VK2YBX
Julian Edgar, Dip.T.(Sec.), B.Ed
Mike Sheriff, B.Sc, VK2YFK
Philip Watson, MIREE, VK2ZPW
Bob Young

SILICON CHIP is published 12 times a year by Silicon Chip Publications Pty Ltd. A.C.N. 003 205 490. All material copyright ©. No part of this publication may be reproduced without the written consent of the publisher.

Printing: Macquarie Print, Dubbo, NSW.

Distribution: Network Distribution Company.

Subscription rates: $59 per year in Australia. For overseas rates, see the subscription page in this issue.

Editorial & advertising offices: Unit 8, 101 Darley St, Mona Vale, NSW 2103. Postal address: PO Box 139, Collaroy Beach, NSW 2097. Phone (02) 9979 5644. Fax (02) 9979 6503.
E-mail: silchip@siliconchip.com.au

ISSN 1030-2662

* Recommended and maximum price only.

PUBLISHER'S LETTER

Sending mail by email

We learn by doing, don't we? And the production of our web-site has been a big learning experience for us at SILICON CHIP magazine. First of all, there was all the learning involved in getting the web-site operational and there was more learning involved in fixing the obvious and not-so-obvious faults. Even now, it is not perfect but it has generated a very good response amongst our readers.

Another learning experience has involved our experience with email. It certainly comes in as a flood and if we are unable to answer it for a few days, as happens when you're running a magazine which must meet deadlines, then the email flood becomes a deluge.

We do try to answer the email as promptly as possible and generally log-on at least once a day to pick up the new messages and send replies. However, often the answer to a particular email is not available on the day it comes in and in fact, it might not get answered for a week or two, as happened recently when I was away on a long-overdue holiday.

Having said that, people can make it much easier for us to reply to their email by following some fairly simple rules. First, please keep the letters and the questions, as simple as possible. The more questions you ask and the more complex they are, the harder it is for us to answer them on the spot.

Second, please, please, do not send us email with attachments unless you really need to do so. Too many people are sending us an email to say that the attachment, often a Word document, is really the letter they are sending. Then, instead of answering the letter on the spot, we have to separately open up the document, produce the answer as a text file, then load it back into the email program and so on. The process is often made harder because people like to use all the fancy formatting available in Word and other programs; that makes it harder to draft quick answers.

If you want to ask us something, do it by email, plain and simple. Sending an email with a letter as an attached document is even sillier than those people who send a fax along with a fax cover sheet to say that they are sending a fax. Why do people do this? It beats me!

Third, if you really want to send us a document as an attachment, send it as a simple text file. You will find it is much quicker to send it at your end, and it is heaps quicker for us to receive and read at our end.

Fourth, if you want to send us images such as .TIF, .BMP or GIFs, do not make the files too small as they will not be suitable for use in the magazine. For example, an image sent at 72 dpi would look very "bit-mappy" if it was published in our magazine. We realise there is a conflict here. You may not want to send a big image file because it takes longer to send. But if it is a too low in resolution and we want to use it, we are going to have to ask you to send it again.

Oh and finally, if you are sending us email, please include your mailing address and perhaps a fax number. If an email "bounces" as they occasionally do, we can then send the answer via fax or mail. Also we like a mail address for any contributor so we can pay them!

Leo Simpson

MicroGram Computers

Mouse Tablet

The Mouse Tablet is a computer input device that allows you to choose between an easy-to-use, high resolution, trackball-free mouse or a precise stylus pen. Both pointing devices have a resolution up to 4064 LPI. The three-button stylus pen provides pinpoint accuracy and writing, drawing & painting abilities. Bundled software includes NetProbe (a built-in Internet direct access utility), PenSurfer and PenGuard.

Cat. 8676 **Mouse Tablet** $159

Ethernet Print Server

Avoid slowing down a work station when a print job is running by installing this small print server. Suitable for Windows 95, Windows NT, Novell, TCP/IP and Unix. Just plug the print server into the printer, connect print server to your Ethernet network and run the menu-driven program to start printing over the network.

Cat. 11288 **Printer Server 1 Parallel Port 10Mb/s** $249

Internal UPS & Power Supply

It's not just a UPS but also a 300W power supply. The UPS is actually built into a standard size power supply and the batteries and front panel occupy a 5.25in drive bay. Apart from power failure, the UPS also protects against over voltage, under voltage, overload & DC short circuit. The unit is available in two sizes - PS/2 or ATX. Optional software provides for automatic shutdown.

Cat. No. 8498 **UPS / PS (PS/2) Int 500VA/300W** $499
Cat. No. 8588 **UPS / PS (ATX) Int 500VA/300W** $439
Cat. No. 8499 **UPS / PS Internal RUPS S'ware** $99

Active Noise Cancellation Headset

Active Noise Cancelling Technology cancels background noise before it's recorded. A must for Speech Recognition. In fact, most speech recognition software programs bundle a passive noise cancellation microphone. Active is even more effective. It's also better for Internet Telephony & Interactive Gaming.

Cat. 3377 **Headset / Desktop - Ear & Mic ANC100** $72
Cat. 3379 **Headset - Ear (Either) & Mic ANC500** $78
Cat. 3380 **Headset - Ear & Mic (Stereo) ANC550** $110
Cat. 3381 **Headset - Ear & Mic (Disconnect) ANC600** $125

Diagnostic Card - PCI & ISA Bus

A dual bus diagnostic card! Simply invert the card to test the other bus. It identifies POST BIOS faultcodes & displays error codes. Diagnostic error codes are provided for AMI, AWARD & Phoenix BIOS. Suitable for 486 / 586 / 686 / Pentium II compatible systems.

Cat. No. 3362 **Diagnostic card for PCI / ISA** $249
Cat. No. 3128 **Diagnostic Card for ISA** $69

Portable Bar Code Laser Scanner

The PHL1600 terminal is a programmable handheld terminal with a compact body, well suited for a variety of indoor portable applications. A rechargeable battery pack, that can be charged in the cradle, or non-rechargeable penlite batteries can be used. Through an IrDa interface the terminal is able to communicate to the cradle, or apart from the cradle to all computer devices that use IrDa communication, like portable computers, notebooks and organizers.

Cat. No. 8526 **Portable Bar Code Laser Scanner** $2190
Cat. No. 8527 **Portable Bar Code Cradle** $625

Printer Sharer

Share up to 4 printers between 40 computers. Transmits data up to 400m at 10,000 characters per second over 6 wire telephone cable. A small 4 way switch attached to a short length of cable allows the desired printer to be selected.

Cat. No. 12029 **Printer Extend - Computer End** $59
Cat. No. 12030 **Printer Extend - Printer End** $59

Ethernet Hubs 10/100 BaseTx

Each individual port on these dual-speed hubs provide 10/100Mbps Auto-Negotiation function which automatically senses & selects the optimum speed at 10Mbps or 100Mbps. Internal switching function allows communications between 10Mbps ports and 100Mbps ports within the same hub, ideal for mixed speed network environment. A 4-port 100Mbps Fast Ethernet palmtop hub is also available.

Cat. No. 11299 **Ethernet Hub 8 Port UTP 10/100 BaseTx** $639
Cat. No. 11298 **Ethernet Hub 16 Port UTP10/100 BaseTx** $1249
Cat. No. 11297 **Ethernet Hub 4 Port UTP 100BaseTx** $199

Web-Based Training from $9.95 per month*

New courses now available! Including Windows 98, Quicken 98, Lotus Notes, Internet Tools (Netscape) and more courses on TCP / IP.

A number of courses are "Microsoft Certified Professional - Approved Study Guides"

*Full details at www.tol.com.au

Over 180 courses on offer

Serial Cards

We have a large range of serial cards providing either 1, 2, 4 or 8 ports. Versatile single, dual & four port cards feature 16550 UARTS, COM 1 to 8 & IRQ 3 -15.

Cat. No. 2297 **1 Port RS232 16550 COM1-8, IRQ 3-15** $80
Cat. No. 2239 **2 Port RS232 16550 COM 1-8, IRQ 3-15** $99
Cat. No. 2333 **Two Port 16650 Serial Card** $129

Plug and Play PCI models also available.

48 Channel DIO Card

This programmable interval timer/counter allows the generation of accurate time delays under software control & provides 48 digital I/O channels. The 8253 chip provides programmable interval timer/counter functions & the 8255 chips provide programmable input/output functions. The 8255 contains three 8-bit ports all of which are software configurable giving a total of 48 I/O TTL lines.

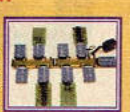
Cat. No. SI8255-1 **48 Channel DIO Card** $138

External Case for CD-ROM or HD

No more overheating! A cooling fan & ventilated front panel allow free air flow. A versatile external case for two 3.5" or 5.25" SCSI half height HDD or CD ROM drives, tape drives etc. Features built-in 80W power supply. Models with 4 & 9 drive bays available.

Cat. No. 6384 **Ext Case 2 x 3.5/5.25"HDD/CD ROM SCSI** $239
Cat. No. 6398 **Ext Case 4 x 3.5/5.25" HDD/CD ROM SCSI** $349
Cat. No. 6399 **Ext Case 9 x 3.5/5.25" HDD/CD ROM SCSI** $590

Parallel Port Data Acquisition



High precision, parallel port, data conversion modules which are ideal for laboratory research, industrial process monitoring & control. Range includes A/D converters & DIO modules, terminal boards & an expansion kit with 5 sockets to allow support for up to 16 modules. The DIO module has 8 digital inputs & outputs and can connect to an 8 opto isolated input & eight reed relay output board.

Cat. No. 17031/2 **12-Bit A/D Converter 0 - 5V/ 0-10V** $239
Cat. No. 17033 **A/D Terminal Board** $109
Cat. No. 17034 **Digital I/O** $209
Cat. No. 17035 **8 Opto 8 Reed Relay** $219
Cat. No. 17036 **Expansion Kit** $109

E & OE All prices include sales tax **MICROGRAM 0299**

Come and visit our online catalogue & shop at www.mgram.com.au

Phone: (02) 4389 8444 sales@mgram.com.au info@mgram.com.au Fax: (02) 4389 8388

Dealer Enquiries Welcome

Australia-Wide Express Courier (To 3kg) $10

We welcome Bankcard Mastercard VISA Amex

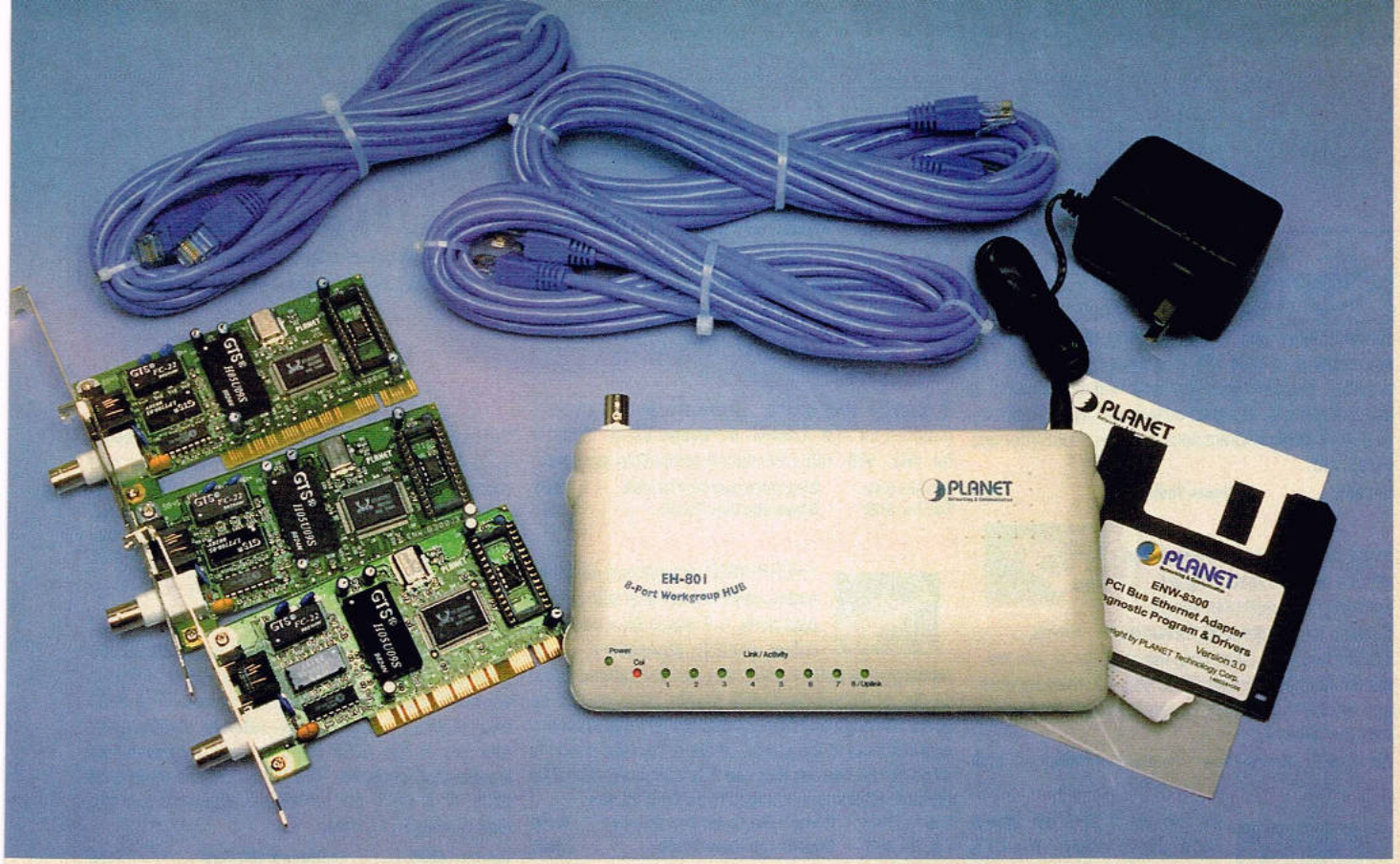
Unit 1, 14 Bon Mace Close, Berkeley Vale NSW 2261

Web site: www.mgram.com.au

FreeFax 1 800 625 777

Vamtest Pty Ltd trading as MicroGram Computers ACN 003 062 100

FreeFax 1 800 625 777



Installing A Computer Network

What sort of computer network do you want in your home, school or small business? Should you run coax or twisted pair cable and when do you need a hub? Here's a primer on basic network planning.

By BOB DYBALL & GREG SWAIN

Getting a new computer network up and running can sometimes be just as challenging as ironing the bugs out of an existing one. However, before implementing a new network, there are a few things you need to consider.

To begin with, you need to know the basics of network wiring so that you can sensibly plan the layout. You also need to think about how the network might need to be expanded in the future. This could involve connecting adjoining buildings, adding additional users or modifying the system to cater for extra network traffic.

Many aspects of networking affect each other, so you need to consider them all before going ahead. The wrong choices can break a network and lead to frustration and added expense later on.

A computer network is made up of a number of different components. Apart from the PCs, you need network cards (one for each PC), network cable and, depending on the type of network, a hub, router or some other device.

Network cabling standards are based on the Open Systems Interconnection model (or OSI model), as released by the International Standards Organisa-

tion (ISO) in 1984. The OSI model helps separate the different functions of a network into seven "layers". These layers are shown in Table 1.

Although there are some grey areas, most networking protocols fit the OSI model. In practice, this means that different networking protocols can successfully coexist on the same network. This concept is known as "protocol independence", which means that a network designer can use the same hardware for different protocols. A simple example of this might involve viewing web pages across an intranet using IPX/SPX instead of, say, TCP/IP.

We'll look more closely at the OSI network layers a little later, when we get to repeaters, switches, bridges and routers.

Ethernet

Ethernet is the most widely used LAN technology today and supports virtually all popular network protocols. It operates according to the Carrier Sense Multiple Access/Collision Detect (CSMA/CD) access method.

OK, let's find out what this mouthful of jargon really means. The name might sound complicated but the principle is really quite simple.

CSMA/CD allows multiple workstations to access a network by "listening" until no signals are detected (Carrier Sense). If a station has traffic to send, it then transmits and checks to see if more than one signal is present (Collision Detect). Each station only attempts to transmit if it detects that the network is free.

If a packet of data is transmitted and a collision takes place, the stations transmitting immediately stop and enter a random countdown period before attempting to re-send the data.

Planning your network

Many small to medium-size networks had humble beginnings. Often, they started "life" as just a couple of PCs networked together in an office, with additional workstations and servers progressively added as required. However, there's a limit to how far you can go with an ad hoc approach. Keep adding equipment and, sooner or later, you're going to run into problems.

It's important to realise that there are a number of ground rules for wiring up a network. For example, the maximum distance between workstations and the number of workstations that can be added are directly related to the type of cable used.

If you need to add lots of workstations or cover large distances, it will be necessary to add repeaters and/or bridges to connect different sections of the network together. In addition, you may have to add switches (or routers) to break up network traffic in areas that are heavily used. Basically, a switch filters unnecessary traffic from individual segments of the network, so that it is faster overall.

In addition to the number of users, bandwidth requirement is an important consideration. Networks operating at 10Mb/s have been the standard in small installations until recently but the new 100Mb/s systems offer substantial performance benefits (at a cost) and are gaining in popularity.

Common cable types

Most small-to-medium networks are run using either coaxial cable or Cat.5 twisted pair cable fitted with RJ45 connectors (the latter look like American-style miniature telephone connectors). However, there are other choices, including optical fibre, and these are summarised in Table 2. Note that the cable is at the "Physical Layer" of the OSI model.

Simple 10Base-2 Network

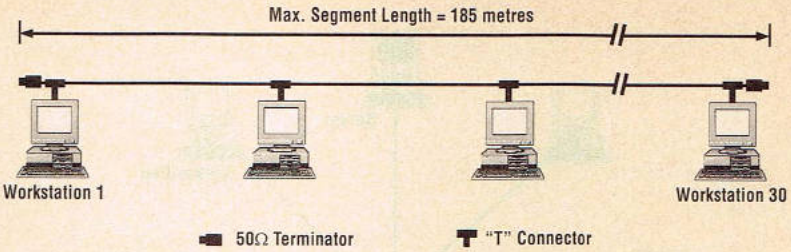


FIG.1: A 10BASE-2 NETWORK has all the PCs wired along a single line, in a "bus" configuration. Each network interface card (NIC) is fitted with a T-piece and these are connected using lengths of coaxial cable fitted with BNC connectors. A 50Ω coax terminator is fitted to each end of the network. A disadvantage with this type of layout is that a break anywhere in the coax generally brings the whole network down.

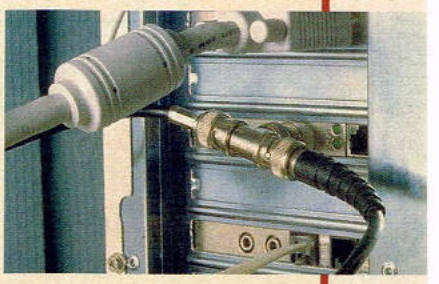


Table 1: The OSI Model

Layer	Function	Data Type
Application	Interface between the user's application & the network	Messages
Presentation	Establishes data formats, translates data, provides data compression & encoding/decoding functions	Packets
Session	Allows server names to identify devices & uses these to establish connections between devices	Packets
Transport	Breaks up data from the session layer and reassembles it to provide reliable connection-oriented data transmission	Datagrams & segments
Network	Gets the data through the network via the most efficient route, using switching, routing & addressing	Datagrams
Data Link	Logical Link Control sub-layer (LLC); maintains the link between network devices	Frames
	Media Access Control sub-layer (MAC); handles physical addressing, ensuring only one device uses the network at a time	
Physical	Translates data into binary format for transmission across physical media	Bits

10Base-T/100Base-TX Network

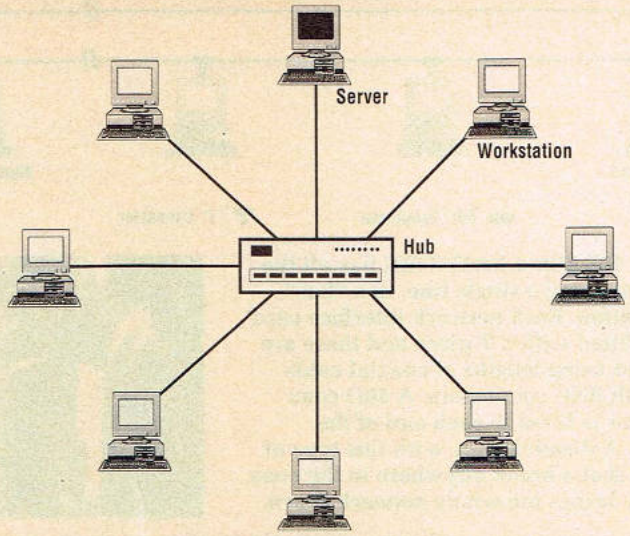
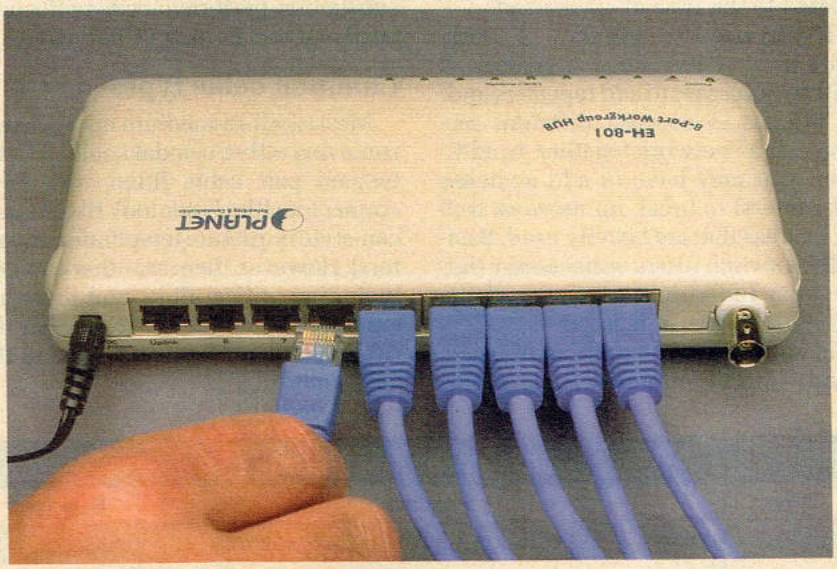
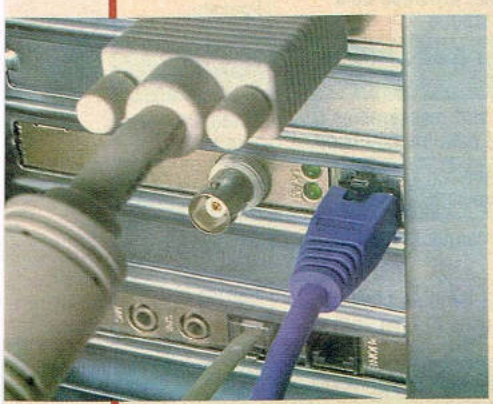


FIG.2: A 10BASE-T NETWORK uses a "star" topology, whereby individual workstations are connected to a central hub using inexpensive twisted pair cable. This type of network is more reliable than the bus network shown in Fig.1, since a broken cable only affects one workstation.





THE CABLES FOR A 10BASE-T NETWORK are fitted with RJ45 connectors which plug directly into the network cards in the individual PCs (left). The other ends of the cables are then plugged into the ports on the hub (see above). The hub shown here has eight regular ports, which means that it can accommodate up to eight PCs on the network. It also has an "uplink" port so that additional hubs can be easily added as the network expands.

As mentioned above, the type of cabling you choose depends on your network requirements and on the "topology" of the network. So let's take a look at the more popular options.

(1) 10Base-2: this option is based on thin, screened 50Ω coaxial cable. For this reason, it also known as a thin-Ethernet system, or as "Thinnet". Its advantages are that it's inexpensive, simple to use and good in high-noise environments.

Fig.1 illustrates a simple 10Base-2 network. Note that all the workstations are wired along a single line, in a "bus" arrangement. Each network interface card (NIC) is fitted with a T-piece and these are connected together using lengths of coaxial cable fitted with BNC connectors. A 50Ω coax terminator must be fitted at each end of the network.

Up to 30 workstations can be connected in this fashion. The maximum length of the network specified for 10Base-2 is 185 metres (without repeaters) and the workstations must be at least 0.5-metres apart.

A disadvantage with this type of layout is that a break anywhere in the coax generally brings the whole network down. In addition, 10Base-2 can only be used in half-duplex mode, the network card either transmitting or receiving at any given time (but not both at once).

10Base-2 is mainly used where relatively few users need to be connected over a long distance (up to 185 metres) and where speed is not an overriding consideration.

(2) 10Base-5: also called thick-Ethernet or "Thicknet", this standard is based on "thick" 50Ω coax. Unlike 10Base-2, the individual network cards are connected to the cable via transceivers and special AUI (application user interface) drop cables fitted with DB15 connector plugs. A 50Ω terminator is fitted to each end of the cable.

The advantage of 10Base-5 is that it can accommodate up to 100 stations over a distance of 500 metres without a repeater. However, this standard is not often used these days, since the thickness of the cable makes it difficult to run. It also requires network cards fitted with DIX connector sockets and is rather expensive for small to medium networks.

(3) 10Base-T & 100Base-TX: perhaps now the most popular standard,

Table 2: Network Cabling Standards

Cabling Standard	Topology	Minimum Cable Spec.	Speed	Max. Length	Min. Length Between Nodes	Max. Segment Length	Max. No. Of Segments	Max. No. Of Nodes	Max. No. Of Nodes/ Segment
Arcnet	Star or bus	RG-62 90/93-ohm	2.5Mb/s	600m	N/A	N/A	N/A	255	32
Arcnet Plus	Star or bus	RG-62 90/93-ohm, UTP or optical fibre (FO)	20Mb/s	Coax: 600m UTP: 120m FO: 3500m	N/A	N/A	N/A	255	32
10Base-5	Bus	50-ohm	10Mb/s	2500m	2.5m	500m	5 + 3	300	100
10Base-2	Bus	50-ohm	10Mb/s	925m	0.5m	185m	5 + 3	90	30
10Base-T	Star	Cat.3	10Mb/s		2.5m	100m		1024	1
10Base-FL	Star	Optical fibre	10Mb/s	N/A	N/A	2000m		1024	1
100Base-TX	Star	Cat.5 UTP	100Mb/s	N/A	2.5m	100m	1024	1024	1
100Base-T4	Star	Cat.3-5 UTP	100Mb/s	N/A	2.5m	100m	1024	1024	1
100Base-FX	Star	Optical fibre	100Mb/s	N/A	2.5m	2000m	1024	1024	1
Token Ring	Star/Ring	STO, UTO or optical fibre	4Mb/s or 16Mb/s	N/A	2.5m	UTP: 45m STP: 101m	33	UTP: 72 STP: 260	

this uses twisted pair cable to connect individual workstations to a central hub or repeater. This arrangement is known as "star" topology, as shown in Fig.2. A 10Base-T network runs at 10Mb/s, while a 100Base-TX network runs at 100Mb/s.

Generally, Cat.5 unshielded twisted pair (UTP) cable is used but shielded twisted pair (STP) cable may be necessary in electrically noisy areas. These cables are fitted with inexpensive RJ45 connectors which plug directly into the hub and into most network cards.

Since all workstations in a 10Base-T network are wired in a "star" arrangement, a broken cable only affects "traffic" to and from one workstation. For this reason, 10Base-T networks are more reliable than 10Base-2 networks using bus topology. 10Base-T networks have an edge in speed over 10Base-2 (and 10Base-5) systems too, if the network cards are used in "full duplex" mode.

Both UTP and STP cables are available in solid core and stranded core. It is important to use the correct cable in a given situation, as the performance differs between the two types. The maximum distance (segment length) between the hub and a workstation is 100 metres and the rule is 10 metres maximum for stranded-core "patch" cables and 90 metres maximum for solid core "LAN" cables.

In a simple 10Base-T network, patch cables are used to connect individual workstations directly to the central hub, as shown in Fig.2. This means that the maximum distance between any two workstations is 20 metres. If greater distances are required, solid-core LAN cable must be used. Fig.3 shows how a mixture of patch cable and LAN cable can be used to connect a workstation to a hub via a wall outlet and a "patch" panel.

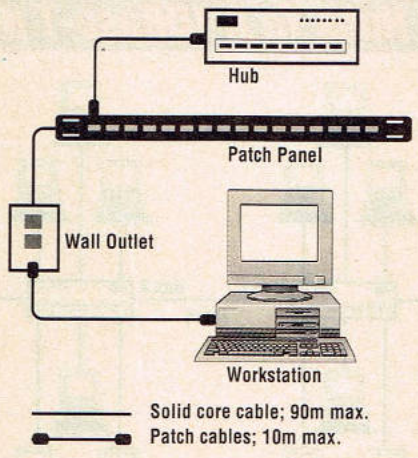


FIG.3: SOLID CORE CABLE must be used to connect a workstation back to a hub for distances greater than 10 metres. This diagram shows how a mixture of patch cable and solid-core cable can be used to connect a workstation to a hub via a wall outlet and a "patch" panel. (Namlea Data Systems).

Apart from less noise immunity (if using UTP), the main disadvantage of 10Base-2 is the need to buy a "hub" to connect all the workstations together. However, 10Mb/s hubs are now a relatively low-cost item, with typical 8-port units selling for about $135. By contrast, an 8-port dual-speed 10-100Mb/s hub will set you back $500 or more.

If you already have a 10Mb/s hub and you are planning a new network, consider buying 10-100Mb/s network cards instead of ordinary 10Mb/s cards (the dual-speed cards are not that much more expensive). In addition, you should buy Cat.5 cabling instead of settling for Cat.3 cable. This will allow you to easily upgrade to a 100Mb/s network later on, simply by replacing your existing 10Mb/s hub with a 100Mb/s unit. Although 100Mb/s hubs are still expensive, their prices are rapidly dropping and so this approach offers an easy upgrade path if you need the extra bandwidth later on.

(4) Arcnet: an older networking standard than Ethernet but still used

Using Repeaters To Extend A Network

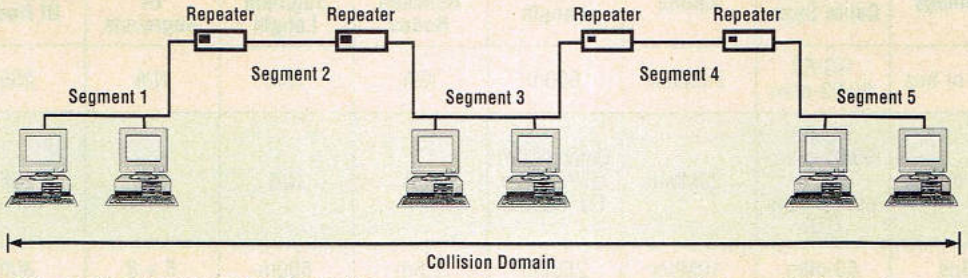


FIG.4: REPEATERS CAN BE USED to extend a 10Base-2 network beyond the basic 185-metre limit. The 5-4-3 rule applies here. This rule states that the network is limited to five segments, four repeaters and three groups of workstations. (Namlea Data Systems).

in some installations. The length of cabling is limited by a maximum propagation delay limit of 31ms.

(5) Token Ring: requiring special network cards, this system is usually more expensive than 10Base-2 or 10Base-T Ethernet networks. It is useful in situations where there is relatively heavy network use, since each workstation is forced into taking its turn for network access. A multistation access unit (MAU) is required to terminate the cables from the workstations.

(6) 10Base-FL & 100Base-FX Optical Fibre: often used where large distances are required and in situations where high levels of electromagnetic interference are present. Fibre optic cabling can be interfaced to Cat.5 twisted pair cabling via converters, transceivers or hubs fitted with fibre optic ports.

Generally, fibre optic cabling is used in large professional installations where performance considerations outweigh the cost.

Repeaters and the 5-4-3 rule

Often, it will be necessary to extend a network further than the basic recommended distance. In that case, you may need to add a repeater, to overcome signal losses in the cable.

A repeater is one of the simplest devices you can use to extend a network. It can be considered as a "black box" that amplifies the signals coming into it, before passing them on to other devices on the network. Repeaters cannot change packet or protocol types; nor can they "segment" a network to reduce traffic congestion.

There are "rules" defining how many repeaters you can use in a network, since too many would cause timing problems and data collisions. With Ethernet technology, the number of repeaters is limited by the "5-4-3" rule. This rule states that the network is limited to five segments, four repeaters and three groups of workstations (ie, only three segments can be connected to workstations). Fig.4

Adding Hubs To A 10Base-T Network

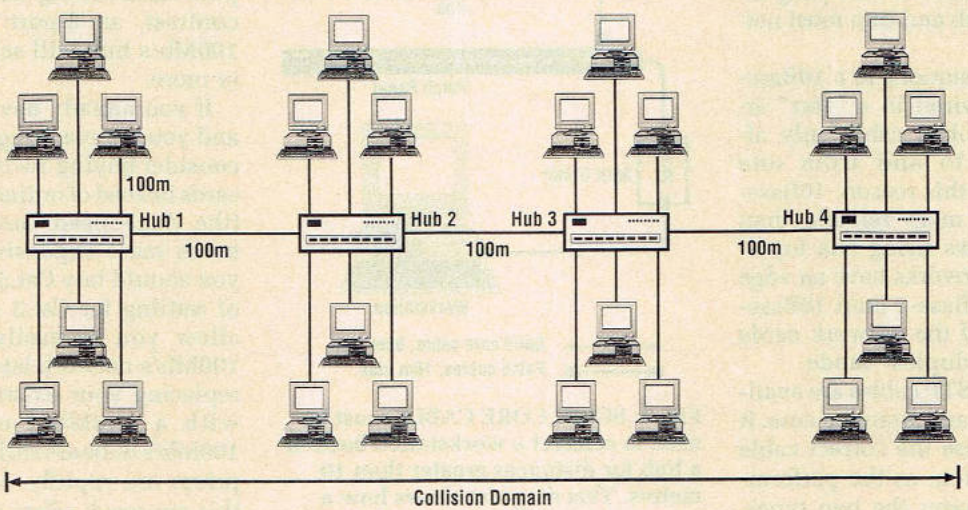


FIG.5: EXTRA HUBS CAN BE ADDED to increase the number of ports as the network grows. A 10Base-T network can have up to four cascaded hubs, each spaced up to 100 metres apart using Cat.5 cable. A 100Base-TX network is limited to two hubs spaced no more than five metres apart but this can be increased using a bridging port. (Namlea Data Systems).

shows the basic scheme.

You can also use repeaters to connect networks in two different buildings together and to link networks using different types of cable.

Some companies, such as Black Box, stock many specialised converters and interface options to patch different types of networks together and/or to extend them over large distances (eg, via fibre optic cable). This equipment can dramatically extend the maximum distance covered by a given network.

Hubs

Hubs are basically multi-port repeaters and are used in 10Base-T (and 100Base-TX) networks to connect servers and workstations together in a star configuration. A passive hub doesn't do much more than provide a way to connect the various parts of the network. By contrast, an active hub can extend the coverage of a network just like a dedicated repeater.

As the network grows, additional hubs can be added to increase the number of available ports. In practice, this involves cascading the hubs together, as shown in Fig.5. The maximum distance between hubs is 100 metres for 10Base-T and 5 metres for 100Base-TX. If you wish to cascade 100Base-TX further than five metres, a bridging port must be used.

As well as their regular ports, many hubs also come with an uplink port. When two hubs are cascaded together, the uplink port on the first is connected to one of the regular ports (it doesn't matter which one) on the second. The uplink port on the second hub can then be used to cascade a third hub, and so on. Fig.6 shows how this is done.

Provided you use an uplink port to connect to the next hub, regular Cat.5 patch cable can be used. Alternatively, hubs that don't have uplink ports can be cascaded by connecting two regular ports together via a crossover cable. You don't use a crossover cable if you connect to an uplink port, because the pins connections are already crossed over in the socket.

As an alternative to cascading, some hubs can also be "stacked" to create one logical hub. This involves using a special cable to connect the hubs together via their "stack" ports. This facility is particularly important in Fast Ethernet environments where only two repeater counts are allowed.

Low-Cost Network Starter Kit

IDEAL FOR USE AT HOME or in a small business, this 10Base-T "Network Starter Kit" from Namlea Data Systems contains all the parts you need to create a local area network (LAN). It comes with an 8-port hub, three network cards, three 5-metre Cat.5 cables and a plugpack power supply.

As supplied, you can network up to three PCs. Up to eight PCs can be connected by adding extra network cards and cables as required.

Two versions are available: (1) Cat. 39NSK0803I with ISA cards; and (2) Cat. 39NSK0803P with PCI cards.

A 100Base-TX fast Ethernet starter kit is also available. This version contains a 100Mbs 4-port hub, two PCI cards and two 5-metre cables (Cat. 39NSK0402F).

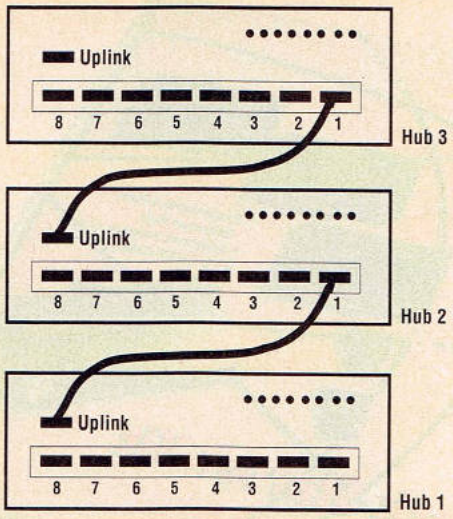
Namlea Data Systems (NDS) is a company that specialises in networking equipment, including switches, hubs, print servers, routers, patch panels, cables and a wide range of connectors and cables.

For further information, contact Namlea Data Systems, 22 Cleg St, Artarmon, NSW 2064. Phone (02) 9439 6966; fax (02) 9439 6965. www.ndsonline.com.au

Hubs are usually non-intelligent devices and will simply pass everything to all workstations. Don't forget to apply the 5-4-3 rule when cascading hubs. This means that you have to ensure that you have no more than four ports between any two "nodes" or points on a network.

As well as the usual RJ45 sockets, some hubs are also fitted with a BNC

Cascading Hubs Via The Uplink Port



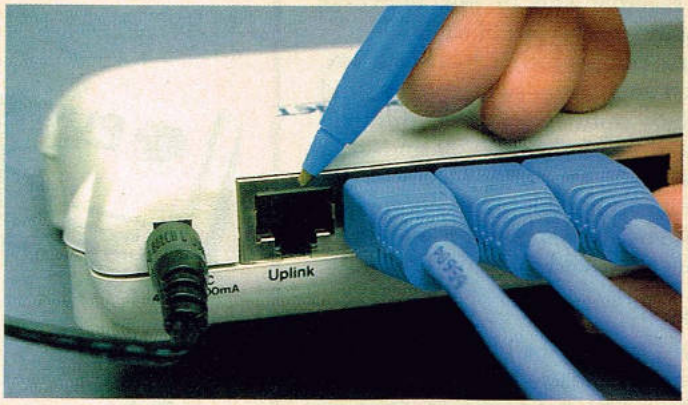


FIG.6: HUBS ARE CASCADED together by connecting the "uplink" port of the first hub to a regular port on the second hub and so on. Hubs that don't have uplink ports are cascaded by connecting two of their regular port together via a special crossover cable.

connector to allow cascading via 50Ω (10Base-2) coaxial cable. By using coax, the hubs can be up to 185 metres apart – a useful increase on the 100-metre limit imposed by Cat.5 UTP cable. As before, each connector is fitted with a T-piece, the coax run between the T-pieces, and the open ends fitted with 50Ω terminators.

This simple feature can save on the cost of buying a repeater. For example, let's say that you have two hubs 160 metres apart, each connected to a 10Base-T network. Provided the two hubs are fitted with BNC connectors, you can easily connect these two 10Base-T networks together using 10Base-2 coaxial cable.

If the distance between the hubs was 1.5km, you could add two repeaters and connect everything together using three 500-metre segments of 10Base-5 coax. However, this would require hubs fitted with 15-pin AUI ports to accept the thick coax. Alternatively, you could use one segment of optical fibre cabling.

Bridges

Bridges are mainly used to connect two similar Ethernet networks together. In addition, they can also be used to "segment" a busy network to decrease data collisions and boost performance. Bridges work at the Data Link Layer of the OSI model.

To get the best from a bridge, it's important to break the network into segments by grouping workstations and servers that work together – see Fig.7. This is done to minimise traffic between different segments. Often, in a business situation, this is simply done on a departmental basis (eg, the accounts department's server and workstations on one side of a bridge and the shipping department's server and workstations on the other side).

Just as with repeaters, there are some specialised bridges to connect networks that use different network media (eg, to convert between Token Ring and Ethernet).

Ethernet switches

Although hubs can be used to increase the size of a network, too much traffic can slow things down. When this happens, switches, bridges and routers can be used to increase the performance by partitioning the network and by filtering network traffic.

Switches are basically multi-port

Linking Two Networks Via A Bridge

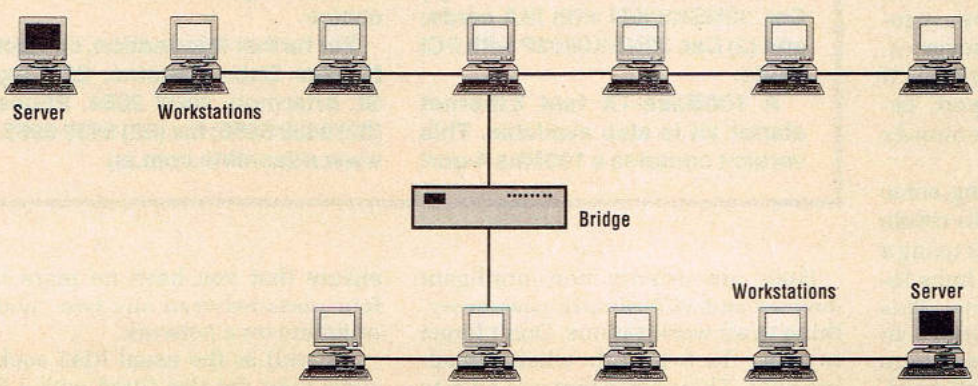


FIG.7: BRIDGES ARE USED TO CONNECT two similar Ethernet networks together or to segment a busy network to decreases data collisions and boost performance.

bridges. They not only partition a large network into smaller "domains" but also filter unnecessary traffic from individual segments of the network. These two steps markedly reduce the incidence of data collisions, making the network faster and more efficient.

If your network is getting a little tired, with too many users wanting too much bandwidth, replacing an ordinary hub with a switch can give a worthwhile increase in performance.

Routers

Routers work within the network layer of the OSI model. As the name suggests, they find the best "route" for data in large, complicated networks. Routers are more "intelligent" than switches or bridges, as they use either MAC (media access control) addresses, IP addresses or other common addresses to determine the best path for data to travel.

For example, an IP router can divide a network into various "subnets" so that only traffic destined for particular IP addresses can pass between segments.

Routers do not pass "non-routable" network protocols, such as the popular NetBEUI protocol. What's more, they are not for the fainthearted, since setting them up can be a little tricky. As with a bridge, a router slows down network traffic as it filters the data to determine the route. However, this filtering "overhead" is relatively insignificant compared with the vast improvements overall that a router can bring to a large network.

A special version of a router, known as a "Brouter", can handle both routable (eg, TCP/IP) and non-routable (eg, NetBEUI) protocols.

Network troubleshooting

If a network or part of a network doesn't work correctly, try to analyse the problem. Confronted with a problem, many people rush in and swap network cards about or fiddle with cables and protocol settings without really thinking about the problem.

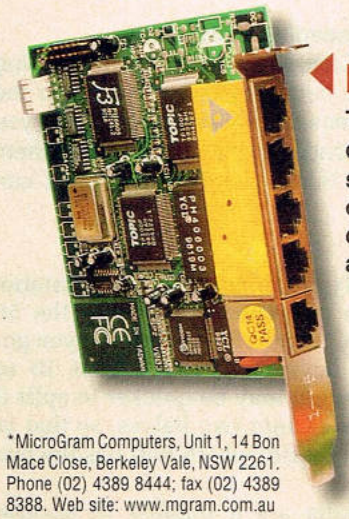
First, make sure that the problem isn't simply due to user error. If it isn't and you're convinced that it's either a hardware fault or a software fault, try starting with a basic network consisting of just a few machines.

If the network was functioning but a problem suddenly develops, check to see if it is reproducible. A simple

Networking Gear From MicroGram*

NETWORK STARTER KIT

IF YOU WANT your first network to be fast, this kit can deliver the goods. It contains all the hardware components required to build a 100Mb/s network for two PCs, including a 4-port hub, two 10/100Mb/s PCI network cards and two Cat.5 cables. Up to four PCs can be supported by purchasing additional network cards and cables. Cat. 11900.



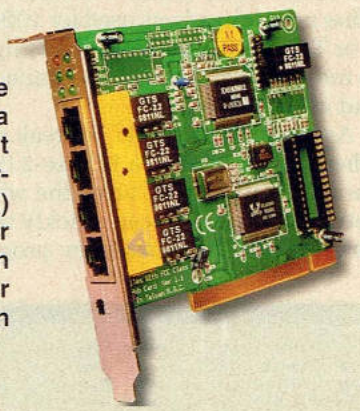
INTERNAL 5-PORT HUB CARD

THIS 100Mb/s 5-PORT HUB card mounts on the backplane of a PC (typically the server) but does not plug into a slot – it only connects to the power supply. The companion display unit (below) mounts in a spare 3.5-inch drive slot. Cat. 11294.

*MicroGram Computers, Unit 1, 14 Bon Mace Close, Berkeley Vale, NSW 2261. Phone (02) 4389 8444; fax (02) 4389 8388. Web site: www.mgram.com.au

5-PORT HUB & LAN CARD

IDEAL FOR SOHO (small office/home office) users, this single unit combines a network card and a 5-port hub into one. It plugs into a spare PCI slot on the motherboard (no external power supply needed) and can auto-sense either 10Mb/s or 100Mb/s operation. Four RJ45 ports on the backplane connector allow up to four more PCs to be networked to the main unit. Cat. 11295.



8-PORT HUB DUAL-SPEED HUB

THIS 8-PORT DUAL-SPEED HUB features automatic internal switching, to allow communications between ports running at 10Mb/s and ports running at 100MBps. It supports stacking (up to four units can be stacked to form one logical hub) and includes a switched uplink port (port 8). Cat. 11299.

Common Networking Terminology

Hubs

A hub is the central point of a 10Base-T network and provides a means of connecting the various elements of the network together in star configuration. Hubs come in various sizes, ranging from 4 ports up to 24 ports or more.

Additional hubs can be cascaded or stacked to increase the number of available ports as the network grows.

Uplink Port

This is a port that's used to connect directly to a regular port on another hub, so that the two hubs can be cascaded. The uplink port has its pins configured to allow regular patch cable to be used. If connecting a regular port to another hub without an uplink port, a crossover cable must be used.

Print Server

A print server is a device with one or more parallel ports and is used to connect a printer (or several printers) to a network. Print servers are intelligent devices, which have their own network addresses and simple setup software.

Cascading & Stacking

Cascading involves connecting two hubs together to increase the number of available ports. When you cascade two hubs, you connect them via RJ45 (Cat.5) cable. Hubs can also be cascaded via a BNC or AUI port (if fitted), to avoid wasting a normal port. AUI ports require special transceivers to connect them to the network.

Stacking also increases the number of available ports and involves connecting the hubs via a special cable. The hubs must have special connectors to allow this. Unlike cascading, stacking creates a single logical hub and doesn't add a repeater count to the network.

Media Converters

Media converters are devices that allow different cable types to be connected together (eg, 10Base-2 to 10Base-T).

reboot can often clear up this sort of problem.

Don't overlook the obvious. Before replacing network cards, check your plugs and cables for loose connections. If one machine in a 10Base-T network fails to work, for example, try changing the patch cable to that machine. Most hubs, switches and other network gadgets used for 10Base-T or Token Ring networks have lights to indicate that the cable is connected and all is well.

As mentioned earlier, a break anywhere in the cable of a 10Base-2 (bus) network will usually bring the whole network down. You can quickly track down where the break is by progressively disconnecting the workstations from one end, transferring the 50Ω terminator to the free end as you go. If you have more than about 10 machines, it may be quicker to split the network into two halves, so that you can identify which half has the problem.

There are a number of excellent tools for network diagnostics but don't forget your DMM. It can easily check for shorts or open circuits on a simple coax network.

To test a coax installation, first disconnect the terminator at one end, then check the resistance of the terminator and the resistance across the cable connector. In both cases, you should get a reading of about 50Ω. That's because, when you measure across the connector, the DMM should measure the resistance of the terminator at the far end of the cable.

If the cable is short circuit, you will get a low reading across the connector. A high reading indicates that the cable has gone open circuit.

Alternatively, an incorrect reading across the connector could indicate a dud terminator at the far end, so remove it and check it independently before condemning the cable. There's not much that can go wrong with a terminator, however; it simply consists of a 50Ω resistor wired across a BNC plug.

Don't forget to check the T-pieces if one or more workstations fails to come up on the network. To do this, reconnect the terminators to both ends of the cable, then disconnect the T-piece from its network card and measure the resistance across it. You should get a reading of about 25Ω (ie, half the resistance of one terminator), since the two terminators act as parallel resistors.

UTP and STP cables, as used for 10Base-T, are usually wired straight through. They can be easily tested for shorts or open circuits using a DMM. Crossover cables are slightly trickier to check, since you have to know which pins are crossed over.

If you have a CRO, you can use it to test for attenuation, either due to long

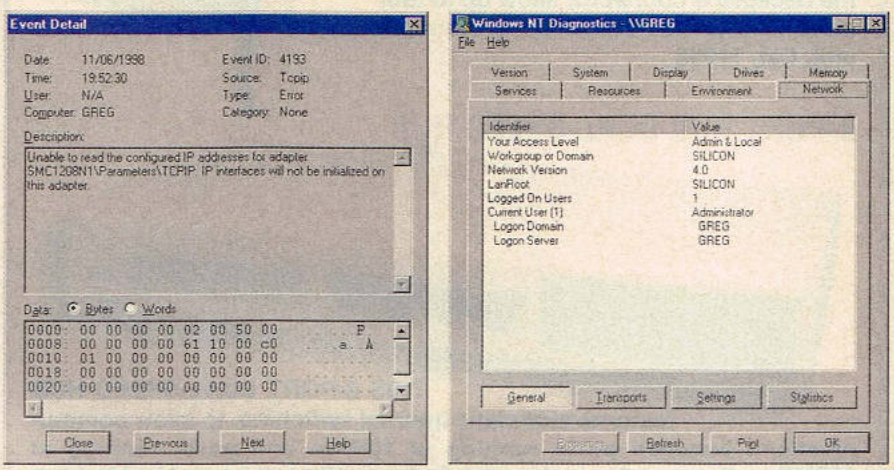


Fig.8: if you have Windows NT, you can use the Event Viewer and Windows NT Diagnostics utilities to help track down networking problems (assuming that the hardware is OK). Alternatively, try using a dedicated diagnostics package.

cable runs, poor connectors or kinks in the cable. If a cable has been kinked, or bent at too sharp an angle, this can cause severe attenuation. This is something which can be detected on a CRO, but which cannot be picked up by a DMM.

Software sleuthing

If the connectors and cables are OK but the network still refuses to function, some software sleuthing may help. For example, if you have Windows NT, you can use the Event Viewer (click Start, Programs, Administrative Tools, Event Viewer) to track errors. You should also check the various tabs under Windows NT Diagnostics (especially the Network tab) to see if there are any problems.

Alternatively, you could try monitoring the network using a dedicated commercial package; eg, the Netmon utility included with SMS. Another good hardware and software package is Black Box's "Ethertester".

Specialised test gear

There's also a vast range of specialised network test gear that's mainly used by professional installers. Included in this range are dedicated cable testers, signal tracers, protocol analysers and time domain reflectometers (TDRs). You can even get all these functions combined into one dedicated unit!

TDRs can determine where a break has occurred in a cable. They do this by measuring the time it takes for a signal to travel down the cable and be reflected back, to give the distance to the break. This makes the TDR an invaluable tool for quickly locating any cabling or socket wiring problems.

Advanced cable testers can typically measure crosstalk, attenuation, resistance, impedance, cable length, capacitance and the attenuation-to-crosstalk ratio. Some can even look at such things as CRC (cyclic redundancy checking) errors, protocol and network statistics, collision errors, and overall network utilisation.

Acknowledgement

Our thanks to Peter Elderton of Namlea Data Systems (phone 02 9439 6966) for their assistance in the preparation of this article and for permission to reproduce material from their catalog.

Networking Test Gear From NDS*

UTP/STP PAIRS TESTER

THIS ENHANCED NETWORK CABLE TESTER detects shorts and open circuits in UTP/STP cables terminated with RJ45, RJ12 and RJ11 modular plugs. The main unit (Cat. 35RJTST6) is all that's necessary for testing patch leads, while the "Network Cable Terminator" must also be included for remote testing (Cat. 35RJTST7 for both units). Similar units are also available for checking thin Ethernet (10Base-2) cables and for testing Ethernet ports (eg, on a hub or network card).

ADVANCED CABLE TESTER

DUBBED THE PENTASCANNER, this handy device can measure crosstalk, attenuation, resistance, impedance, cable length, capacitance and the attenuation-to-crosstalk ratio. It can be used to print easy-to-read certification reports, features customised "auto-testing" and can capture data and upload it to your PC for later analysis using specialised software. Cat. 35RJPS.

*Namlea Data Systems, 22 Cleg St, Artarmon, NSW 2064. Phone (02) 9439 6966; fax (02) 9439 6965. www.ndsonline.com.au

CAT.5 CABLE TESTER

THE MICROSCANNER is designed to check continuity and wiring configuration in Cat.5 cables and can also measure cable length. A tone function allows cables to be traced. Cat. 35RJMS.

WIREMAP SCREEN

10Base-T cable (2-pair, 4 wires)

LENGTH SCREEN

70-metre cable

DICK SMITH ELECTRONICS

Where do you go for new books and savings on test equipment ?

1.25GHz Handheld Frequency Counter

Ideal for measuring radio frequency transmissions and servicing stereos, videos, computers and cordless phones. This incredibly easy-to-use 10Hz to 1.25GHz frequency counter has an 8-digit LCD display, data hold, relative management and data record (min, max & average). Also features selectable resolution, period measurement and more. Complete with telescopic antenna and BNC to alligator-clip leads.

Q 1322

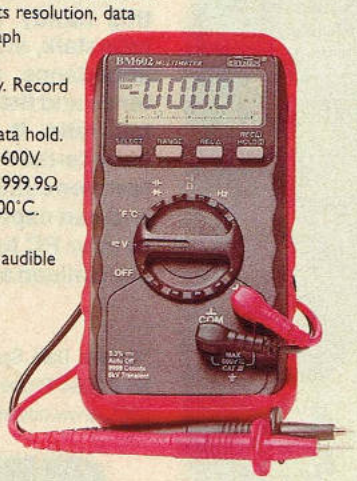
SAVE $100 **$149**

Digital Multimeter with Temperature

Designed for industrial and HVAC applications with safety in accordance with IEC1010-1 installation category III for 600V. Features 4 digits 9999 counts resolution, data updates 4 times per second, bargraph updates 20 times per second, four selectable sensitivities on frequency. Record maximum, minimum, maximum to minimum, average. Relative zero, data hold. Auto power off. DCV 999.9mV to 600V. ACV 999.9mV to 600V. Resistance 999.9Ω to 40MΩ. Temperature -20°C to 500°C. Capacitance 1.000µF to 10.00mF. Frequency 9.999Hz to 50kHz. Fast audible continuity. Diode test, splash proof and more.

Q 1566 **$179**

BRYMEN®



1.3GHz Bench Type Frequency Counter

You can rely on this 9-digit universal counter for quick and accurate measurement of a wide range of frequencies. Measures frequency, period, totalise, frequency ratio, frequency difference, RPM, pulse width and duty cycle.

Q 1316

SAVE $50 **$299**

Strobe Alarm Mk2

Upgraded to include a DC power socket. Features a 120dB siren with a 10-metre range and 10-second entry delay. Additional accessories available: L 5036, L 5037, L 5038 and L 5039.

L 5033

$79.90

Strobe Alarm Mk2 Complete System

Now with a DC power socket to replace the 4 x AA batteries, this complete system in one package is easy to install. Features two remotes, reed switch, glass sensor features DC power socket that replaces the 4 x AA batteries.

L 5032

$179

Encyclopedia of Electronic Circuits Volume 7

Even more new circuits drawn from Popular Electronics, ETI, Elektor, RCA, GE, National Semi-conductors and Radio Electronics.

B 1768

$99.95

1999 Scanner Fanatics Frequency Register

New edition of the original radio frequency listing for radio scanner hobbyists and enthusiasts that set the standard. Covers all of the popular frequencies on a State by State basis.

B 4212

$36.95

Upgrading and Maintaining PCs

By Schueller and Veddeler. Written in a non-technical style for those daunted by PC technical reference books. Includes over 200 photos and illustrations and a CD ROM.

B 6141

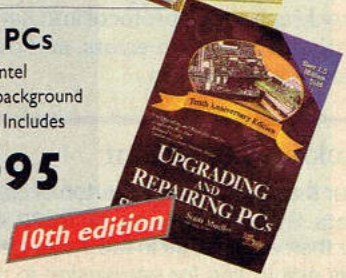
$95

Upgrading and Repairing PCs

By Scott Mueller. Covers modem-based Intel compatibles and provides reference and background information for new readers to catch up. Includes CD ROM.

B 6197

$109.95



DICK SMITH ELECTRONICS

That's where you go!

Where do you go for great new kits this year ?

DICK SMITH ELECTRONICS

HUGE RANGE OF TOP QUALITY KITS!

Digital Trigger Adaptor, Mk II

- An updated version of the 1995 Digital Trigger Adaptor (DTA), utilising a complex programmable logic device (CPLD)
- The adaptor, when connected to a CRO, will trigger the scope when all relevant input conditions are met.
- Eight inputs (expandable up to 24 with slave units) • Frequencies up to 20MHz • Trigger pulse delay from 1us to 1ms after preselected event • 1/3 the size of the original kit, with all logic programmed into the CPLD chip • Source code included on floppy disc

K 1460

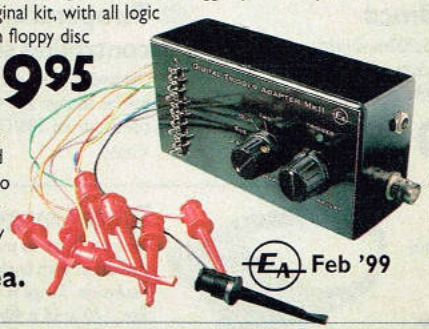
This kit does not include a CPLD chip. Please read on...

$59.95

If you have bought the Vantis starter kit, *(K 1450)* you can use the chips included and program them using the files included on floppy disc in the DTA kit. However, if you simply want to buy the kit and not worry about programming etc, then you have an option of a pre-programmed M4 32/32 chip – simply insert this into the assembled DTA kit for immediate use.

$19.95ea.

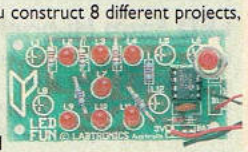
K 1461



EA Feb '99

PIC-based LED Fun Kit

- Have fun and learn about Microcontrollers at the same time
- One board lets you construct 8 different projects, including a timer, dice roller, mini alarm and more!
- Includes buzzer, LEDs, programmed IC (PIC) and all components
- Supply voltage: 3V DC



NEW

K 3167

$14.95

Silicon Chip Feb '99

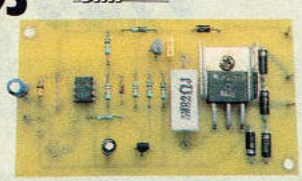
Engine immobiliser Mk II

- Circuit stalls engine when activated
- Connects directly to ignition system
- Kit can be assembled and used independently or can also be interfaced with K-4304 control module (keypad)
- Power supply: 12V DC
- Includes all components, case and PCB

K 4303

$29.95

Silicon Chip Dec '98



Immobiliser Mk II Keypad

- Interfaces with the new Immobiliser kit
- Choose your own 4 digit code for arming/disarming
- No hidden switches required or keys to carry
- Can be hidden or mounted for visible deterrence
- Power supply: 12V DC
- Supplied with hardware, keypad module, PCB and all components
- Specially designed quality metal case

K 4304

$24.95

Actual product may differ from image shown

Silicon Chip Jan '99

NEW

Screecher Car Alarm Mk II

- Utilises a high-output, compact piezo siren to blast an intruder inside your car
- Compact, easy to install and extremely effective
- Features entry/exit delays, flashing warning LED
- Circuit includes transition sensitive triggers
- Power supply: 12V DC
- Includes all components, piezo siren, case and PCB

K 4301

EA Jan '99

$29.95

NEW

Signal–triggered mains switch

- Turns on your entire home entertainment setup/hi–fi system with just one switch
- Activate any piece of gear that needs to be on when audio signals are present
- Includes extra safety features
- Includes all components, hardware, PCB, case, pre–punched and screened front panel

K 5418

$49.95

SAVE $20

Silicon Chip Oct '98

We believe in quality. Don't forget. . . Our kits are tested and thoroughly checked before they make it to our shelves. Our construction materials are second to none and our instruction manuals are customised with the hobbyist in mind. For the best range of kits that won't disappoint:

DICK SMITH ELECTRONICS

That's where you go!

Stamp-based universal timer

- Timer circuit that utilises the features of the Stamp microcontroller
- Features LEDs, and piezo buzzer to indicate events
- Multiple inputs for design flexibility
- Includes relay, components, and multi-purpose PCB
- Power supply: 12V DC
- *K 1408*

$18.95

Stamp microcontroller not included (uses K 1401 Basic Stamp)

NEW

Silicon Chip Jan '99

direct link

Direct Link is equipped with the service centre to supply you with a hassle free delivery direct to your door. PHONE 1300 366 644 to place your order

Availability: Our kits consist of many different parts from numerous suppliers. Whilst we have consulted closely with them and are satisfied as to their ability to supply, sometimes problems can arise in obtaining all of the parts. This means there is a slight chance that availability may be delayed. Rainchecks are available, however if you'd like to check beforehand, please don't hesitate to contact your local store.

DICK SMITH ELECTRONICS

That's where you go!

DICK SMITH ELECTRONICS

Where do you go for multimeters, oscilloscopes and soldering irons?

Line Fuseholder

M205 250V 10A • High temperature 105°C black polyamide nylon 66 casing • 250VAC 10Amp rating • 200mm lead included • Fast connect. • Small, space saving line fuseholder. • Suits M205 fuses

P 9962

FEBRUARY ONLY

$1.95

Engine Analyser

Checks RPM, dwell angle, points and battery charging system. Includes inductive pick-up, test leads and carry case.

Q 1556

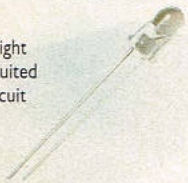
$99

LED 5mm Hi-bright yellow 5000mcd

Features extreme focal concentration of light with 5,000mcd light output and 8 degrees viewing angle, makes this product well-suited to "key-ring" torches, optical experiments using LDRs as a circuit isolator. Many more applications.

Z 4009

$2.50



Temperature controlled soldering iron

Lightweight iron with non-burn silicon cable, holder sponge and tip. Variable temperature control from 200°C to 500°C.

T 2000

$158

Adjustable Visor Magnifier

This lightweight visor simply slips onto your head and you flip it down once a magnified view is required. Has selectable 2.2x and 3.3x magnification.

T 4593

$29.95

Digital megohmmeter

Portable, easy to use 3½ digit meter for one hand operation with backlit LCD. Provides 500V to test insulation. Range is 20MΩ – 2000MΩ. Size: 170 x 44 x 40mm (HWD)

Q 1490

$199

NEW

Butane blow torch/ soldering iron

A large butane powered blowtorch with adjustable flame (up to 1300°C) as well as a soldering iron tip.

T 1396

$36.90

Infrared thermometer

Non contact temperature measurement

Measure temperature from a distance with this portable compact unit. The unit range is -20°C to 260°C, it features backlit LCD, auto hold and auto power off functions. Field of view is 65mm @ 1 metre.

Q 1448

$249

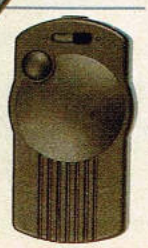
NEW

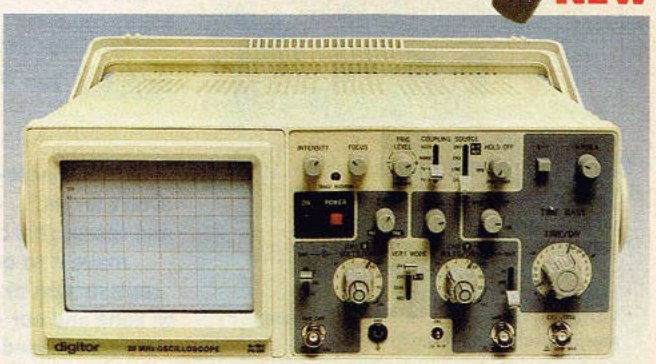
Twin lens laser pointer

This 1mW model uses a switchable dual-lens system to either project a small red dot onto objects up to 50m away (indoors), or to project a straight line that can be used to visually underline text or images that are out of reach. Operates on 2 x AAA batteries

T 2904

SAVE $40 **$49.95**





34-range Digital Multimeter

Features a pop up LCD. Ranges DCV, ACV, DCA, ACA, capacitance, resistance, diode, transistor and audible continuity.

Q 1429

BONUS **$79**

3.5 DIGIT 17 RANGE MULTIMETER WORTH $49.90 Q 1443

24 range 240V rated digital multimeter

- 3.5 digit (2,000 count) LCD
- Maximum hold and data hold
- Diode and continuity test
- Mains rated - safe for 240V mains measurements
- Protective rubber holster

Q 1563

SAVE $20 **$99**

Good value, low cost 20MHz OSCILLOSCOPE

- Dual trace • 20MHz bandwidth • 17.5ns rise time • 1 mV/division sensitivity • Operating modes - Ch1, Ch2, alt, chop, add/subtract
- Selectable trigger sources - Ch1, Ch2, alt, external, line • Sync filtering for stable display of TV signals • Sweep speed 0.1µs - 0.2s/div • Sweep magnification x 10

Q 1802

Includes 2 CRO probes **$649**

DICK SMITH ELECTRONICS

That's where you go!

Where do you go for new BASIC stamp technology?

DICK SMITH ELECTRONICS

BASIC stamps are small computers that communicate with electronic devices using BASIC programs. Now you can build smart electronic projects with the inexpensive, simple-to-use, powerful BASIC stamp.

BASIC Stamp I Revision E

- Runs PBASIC programs with 8 I/O lines
- 256 bytes EEPROM (program and data)
- 80 instructions maximum program length
- Parallel PC interface
- Insert into a carrier board (K 1402), connect with a cable and program using any IBM PC running DOS
- 9V DC power required
- 4 MHZ oscillator

K 1401

$79

Available through mail order, PowerHouse and selected stores

NEW

BASIC Stamp I Carrier board K 1402	$39
Parallel port interface for Stamp I K 1407	$19.95

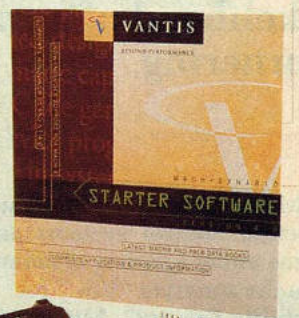
HIGHLY POPULAR

Vantis Mach 4 CPLD Starter Kit

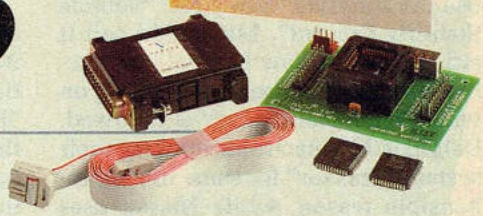
Bring your creative ideas to life from your personal computer using Vantis programmable logic.

This kit is designed as an entry-level introduction to programmable logic and desktop in-system programming. See the article in Electronics Australia Nov '98 and Feb '99 for an example of the benefits of using complex programmable logic devices! Kit includes Synario Starter software Rev 2.0, MACHPRO software, cable, programming board, manual, two MACH4 44 pin devices and requires Win 95 or NT and 5V power supply.

K 1450



LIMITED STOCK **$99**



Programming and Customizing the Basic Stamp Computer

A friendly introduction to building projects with BASIC stamps. With 10 complete projects and explanations. This book is a great start if you have no electronic or programming skills.

B 4807

NEW **$77.95**

Available through mail order, PowerHouse and selected stores

BASIC Stamp Development Kit

Includes Stamps I & 2 manuals, cables for Stamps I & 2 and programming and software to get you started. With certificate for 3 months free technical support

K 1405

$149

NEW

EA/SC magazine is now on sale at all our New Zealand stores!

direct link

PHONE, FAX & MAIL ORDERS

PHONE: 1300 366 644 (Local Call Charge) **FAX:** (02) 9395 1155

MAIL: **DICK SMITH ELECTRONICS,** Direct Link Reply Paid 160, PO Box 321, North Ryde NSW 1670 (No Stamp Required)

Please add postage (up to 5kg) to your order, as follows:

• $4.00 ($1 Up To $50) • $7.50 ($51 Up To $100) • $9.00 ($101 Up To $500) • $11.00 (over $500) (quote available for air/road freight or if over 5kg) email: directlink@dse.com.au (enquiries only)

•Major Credit Cards Accepted. • Gift Vouchers Available

Not available at all authorised stockists.

NEW STORES AND RELOCATIONS

ACT	Fyshwick	Cnr. Townsville/Albany Sts	6293 3399
NSW	Penrith	PowerHouse, cnr Batt & Mulgoa Rds	4721 1544
NSW	Rockdale	Shp M2 Rockdale Plaza, Princess Hwy	9588 9309
VIC	Altona Gate	Altona Gate S/C Millers Rd	9314 6611
	Carnegie	PowerHouse, 1048-1054 Dandenong Rd	9569 2644
	Greensborough	Shop 2, 16-22 Main St	9432 5125
WA	Mandurah	Unit 1, 318 Pinjarra Road	9586 9666

B 3687

DICK SMITH ELECTRONICS

That's where you go!

Traction Control Systems

Using electronics to make your car corner better!

Many of the world's car manufacturers are now adopting traction control systems for their vehicles. These systems, often fitted in conjunction with all-wheel drive, reduce the likelihood of a car leaving the road during cornering.

By JULIAN EDGAR

Many car manufacturers now have traction control systems and these come under a variety of names. Lexus use the acronym "VSC" for "Vehicle Stability Control". Mitsubishi call it either "Active Yaw Control" or "Active Stability Control", depending on which technical strategy is followed. Delphi (GM's electronic arm) tag their system "Traxxar" for some incomprehensible reason, while Nissan uses the ghastly acronym "ATTESA ET-S" for their 4-wheel drive system which incorporates stability control.

Finally, Mercedes Benz call such systems "ESP", for "Electronic Stability Program". Such is the sophistication of the system, it could stand for "Extra Sensory Perception" – and that's as good a reason as any for sticking with the term "ESP" throughout this article.

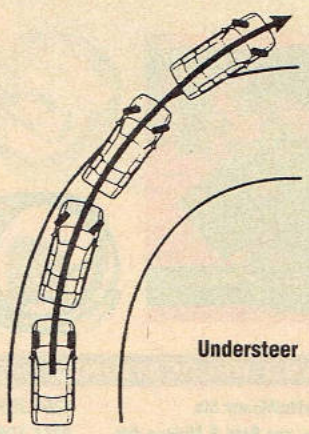


Fig.1: understeer occurs when the front of the car slides first. An understeering car will tend to head straight on, rather than following the corner.

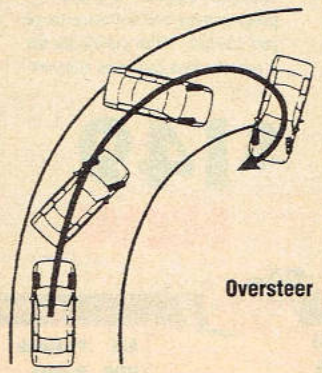


Fig.2: oversteer occurs when the rear of the car slides first. An oversteering car will spin if no correction is made.

Whew; that's got the nomenclature out of the way!

Good drivers, bad drivers

A vehicle transmits all its cornering and acceleration forces through the contact areas of its tyres. Each of these contact "patches" is only about the area of a large shoe print and four of these must control a vehicle with a mass of perhaps 1.5 tonnes and travelling at speeds of 30m/s or more. Viewed in this light, it can be seen that hard braking, cornering and acceleration can be very much a balancing act – exceed the levels of grip provided by the tyres and regaining control could require a very skilled driver indeed.

However, most of us aren't skilled drivers, especially in an emergency situation where a combination of hard cornering and braking may be needed. This type of swerve, brake, recover situation often results in a complete loss of control, unless the driver is skilled at such manoeuvres.

But what if an electronic system was constantly measuring and evaluating individual wheel speeds, steering input angle, vehicle yaw and vehicle acceleration? Such a system could react far faster than a human driver and, using algorithms developed through extensive testing, take the appropriate action to ensure vehicle stability. In short, it would eliminate those heart-stopping moments when the back of the car attempts to overtake the front – a boon for those who drive in icy conditions!

It would also prevent loss of control if the road condition changes suddenly or if the driver makes an error, such as entering a corner too quickly.

But do such systems work? Early in its ESP development, Mercedes Benz

placed 80 of its vehicle owners in the Mercedes driving simulator in Berlin. At 100km/h, an icy situation was suddenly simulated on four road bends, the vehicle's grip on the road decreasing by more than 70% within a few metres. Without any form of ESP, 78% of the drivers left the road. By contrast, when the ESP system was activated, all drivers safely negotiated the bends.

Data collected by the General Motors Safety Center indicates that 29% of severe accidents in the USA are caused by loss of vehicle control. This means that ESP systems can play an important role in vehicle safety – both by negating the effects of driver behaviour and by allowing the driver to retain control in changing road conditions.

Cornering behaviour

Routine driving behaviour occurs well within the limits of tyre adhesion. This means that the cornering forces developed between the road and the tyres remain proportional to the tyre slip angles. It also means that, at a given speed, the yaw rate of the vehicle remains approximately proportional to the steering angle.

However, if the vehicle speed or steering angle continues to increase, a point is reached where the cornering forces no longer increase. When this occurs, small changes in lateral forces can produce large changes in the slip angles of the front or rear tyres. Conversely, large changes in slip angles can result in little or no change in lateral forces.

When the limits of adhesion are reached, a cornering vehicle behaves in two distinct ways. If the front tyres are the first to lose grip, the car is said to understeer. The behaviour of an understeering car is shown in Fig.1. The car leaves the road on the outside of the corner, because the front wheels are "under" steering; ie, not steering enough!

Conversely, if the rear tyres lose grip first, the car oversteers. Fig.2 shows the path that an oversteering car takes. As can be seen, if no correction is undertaken, oversteer can result in a spin.

It's important to realise that the amount of lateral grip that a tyre can develop depends on both the cornering and acceleration loads placed on it (among other things). A powerful rear-wheel drive car may be prone to "power oversteer", where lateral traction is lost because the rear tyres' grip is overcome by the magnitude of the torque being applied. Under a combination of heavy braking and strong cornering, a loss of lateral grip will occur at much lower cornering accelerations than if a steady speed was being maintained. These factors influence the ESP control strategy, which is most effective in active 4-wheel drive cars.

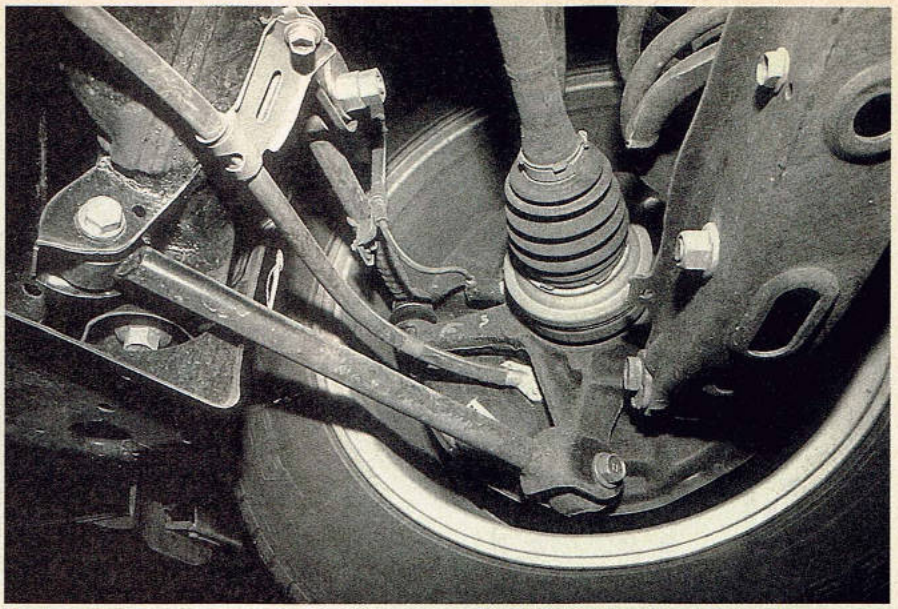


Fig.3: speed sensors are integrated into the hub of the car. Here the cable going to the sensor can be seen just to the left of the drive shaft.

Signal inputs

Before an ESP system can perform any control corrections, it must know how the vehicle is currently behaving. It does this by using a number of sensors, which are distributed around the car.

All cars fitted with ESP have an anti-lock braking system (ABS) fitted. This means that individual wheel-speed sensors are already present. It also makes it relatively easy to implement a system that controls the vehicle by separately braking individual wheels.

In most vehicles, the speed sensors typically use a toothed wheel rotating past an inductive sensor. Fig.3 shows a Lexus speed sensor, as seen in its normal (installed) state. The cable going to the sensor can be seen just to the left of the driveshaft.

In addition to speed sensing, ESP systems also require a means of detecting the steering angle, vehicle yaw rate and vehicle acceleration. The steering angle sensor detects the amount and direction of steering lock being applied.

Lexus vehicles use an optical sensor to perform this function (see Fig.4). This particular device uses three photo interrupters, which work in conjunction with a slot-

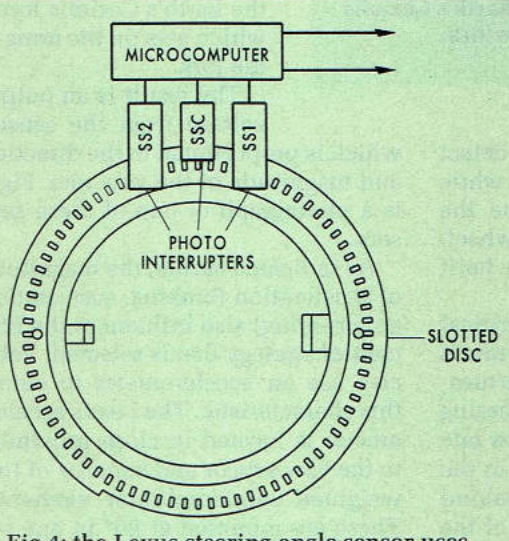


Fig.4: the Lexus steering angle sensor uses an optical design. Three sensors are used in conjunction with a slotted disc.

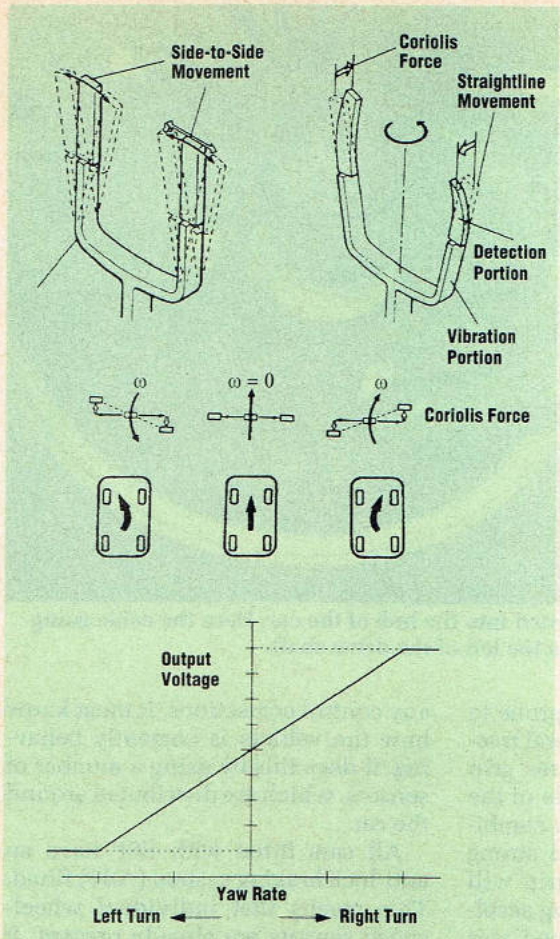


Fig.5: the Lexus yaw rate sensor uses a piezoelectric vibration type rate gyro. The resonator is shaped like a tuning fork, with a vibrating portion and a detecting portion mounted at 90° to each other and located on each arm of the fork. To detect the yaw rate, an AC voltage is applied to the vibrating portion, exciting it. The detecting portion of the assembly is then distorted by a certain amount and direction by the Earth's Coriolis force acting on the arms of the fork.

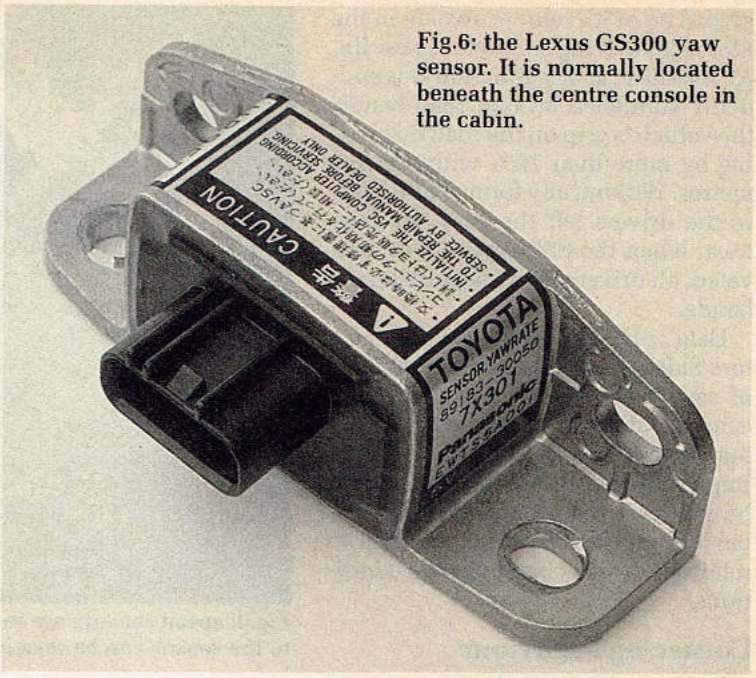


Fig.6: the Lexus GS300 yaw sensor. It is normally located beneath the centre console in the cabin.

ted disc. Two of the sensors detect steering angle and direction, while the third is used to determine the neutral position of the steering wheel. Self-checking mechanisms are built into the sensor.

The vehicle yaw rate is a critical input for ESP systems. The yaw rate is the speed at which the vehicle is turning around a vertical axis passing through the centre of the car. Yaw rate sensors are usually positioned in the middle of the car – directly behind the gearshift lever in the case of the Lexus models. However, the Delphi Traxxarä system locates this sensor under the rear parcel shelf.

The Lexus yaw rate sensor uses a piezoelectric vibration type rate gyro. The resonator is shaped like a tuning fork, with a vibrating portion and a detecting portion mounted at 90° to each other and located on each arm of the fork – see Fig.5. To detect the yaw rate, an AC voltage is applied to the vibrating portion, exciting it. During yaw motion, the detecting portion of the assembly is distorted by the Earth's Coriolis force, which acts on the arms of the fork.

The result is an output voltage from the sensor, which is proportional to the direction and magnitude of the yaw rate. Fig.6 is a photograph of one of these sensors.

As indicated earlier, the magnitude of acceleration (braking, acceleration or cornering) also influences the ESP control strategy that is selected. Vehicles use an accelerometer to detect this characteristic. The Lexus accelerometer is located in close proximity to the yaw sensor and consists of two weighted semiconductor elements. These are mounted at 90° to one another, with each at 45° to the longitudinal axis of the car – see Fig.7. The outputs from the two sensors are fed to the ESP control unit, which calculates the horizontal acceleration in all directions.

Depending on how the ESP system is integrated with other electronic systems in the car, additional sensors may be fitted to detect brake fluid pressure and throttle opening. In most cars, these sensors are already present and so they can be included in an ESP system for very little additional cost.

Signal outputs

The outputs of most ESP systems are used to actuate individual wheel brakes and reduce drivetrain torque to selected wheels. In no system is the steering angle automatically changed, so the wheel isn't suddenly wrenched from your grip as the computer takes over! In 4-wheel drive cars, an ESP system changes the front/rear torque distribution, while one Mitsubishi model can even change the side-to-side torque distribution!

Many ESP systems use braking as their primary control mechanism. The Lexus GS300, for example, integrates the hydraulic aspects of the ESP, ABS and conventional braking systems into one package. Instead of having a separate hydraulic master cylinder, vacuum booster and ABS hydraulic control unit, these systems are all incorporated into one firewall-mounted assembly.

An impressive array of hardware is built into this compact unit, as fol-

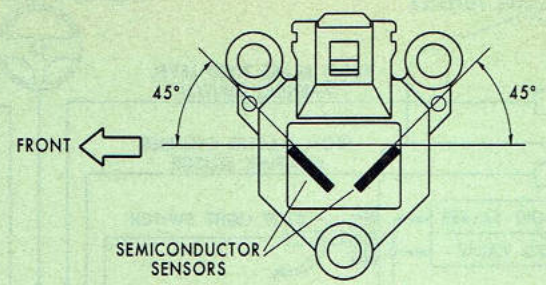


Fig.7: the Lexus accelerometer uses two sensing elements mounted at 90° to each other, with the assembly at 45° to the longitudinal axis of the car.

lows: (1) a pump and pump motor; (2) a nitrogen-charged pressure accumulator; (3) three pressure switches; (4) a relief valve; (5) the brake fluid reservoir; (6) the master cylinder; (7) the brake booster, which applies accumulator pressure; (8) four switching solenoid valves, to direct fluid pressure to any or all of the wheels; and (9) four pressure control solenoid valves that regulate the hydraulic pressure applied to each wheel's brake.

A photograph of this marvel is shown in Fig.8. Note the small lifting hooks positioned on the assembly (we can only conclude that it's installed using a small block and tackle)! Other vehicles in the Lexus range retain a more traditional approach but this integrated hydraulic unit clearly shows the way of the future.

The engine torque is reduced by reducing the throttle opening. The Lexus models use electronically-controlled throttle bodies, so this is easily achieved. Other systems retard camshaft timing (when variable cam timing system is used), reduce the ignition advance or even bypass individual fuel injectors.

Fig.9 shows a block diagram of the complete stability control system used in the Lexus GS300.

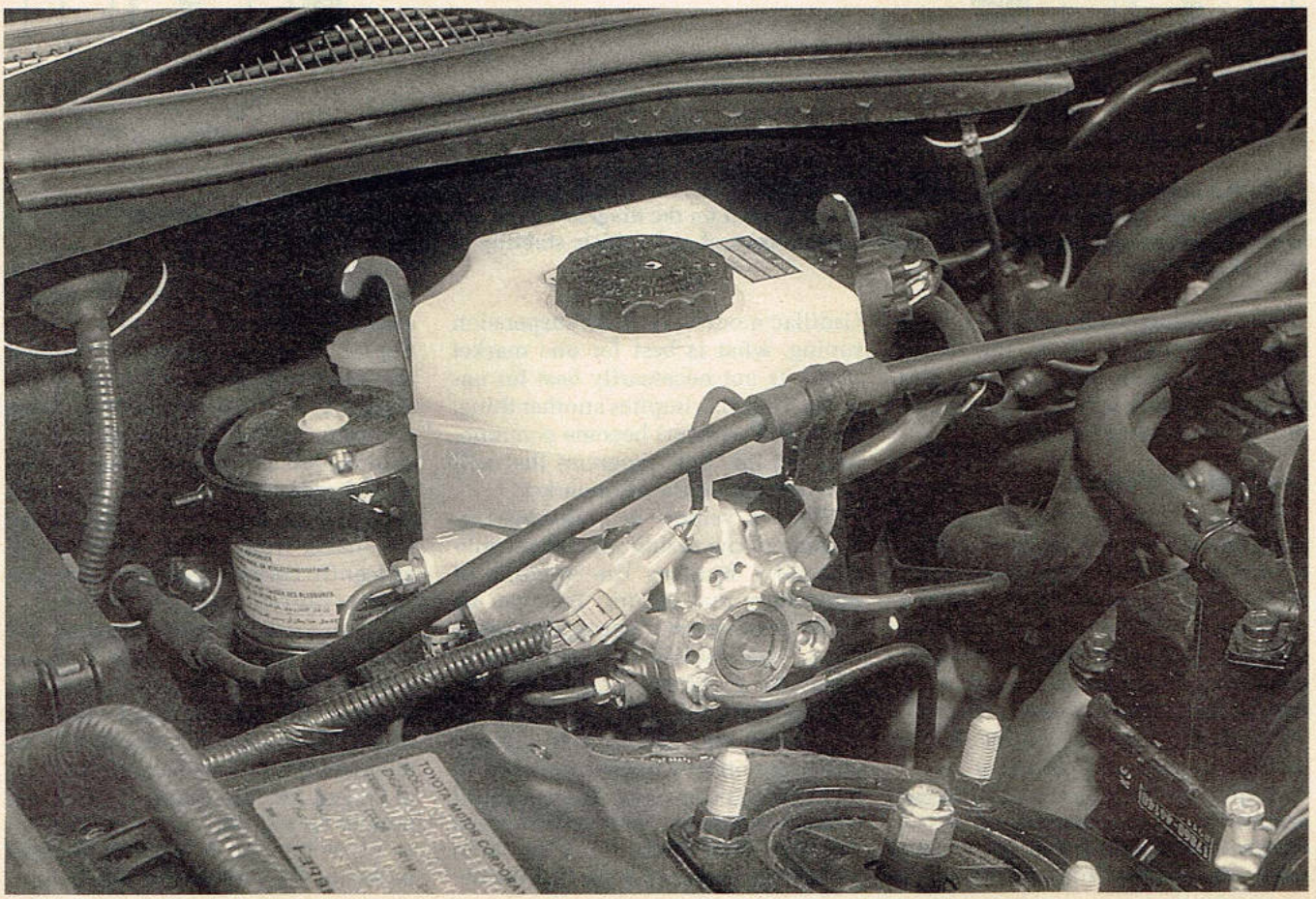
Mitsubishi uses a Torque Transfer Differential in their Automatic Yaw Control system. This differential is able to regulate the amount of torque being transferred to each wheel on the one axle. Currently, only the rear axle can be controlled in this manner.

The system works by using an electrically-controlled hydraulic unit which engages wet multi-plate clutches by varying amounts, to give the active torque split. Fig.10 shows the system, which is being used in 4-wheel drive performance cars and is said to be especially effective in sharp corners.

Nissan's ATTESA ET-S 4-wheel drive system has a similar wet multi-plate clutch system. It is used to distribute torque to the front wheels as required, to give maximum stability.

Other outputs of an ESP system in-

Fig.8 (below): the Lexus GS300 hydraulic assembly. It integrates the ABS hydraulic control unit, the brake booster and the control valves for the stability control system.



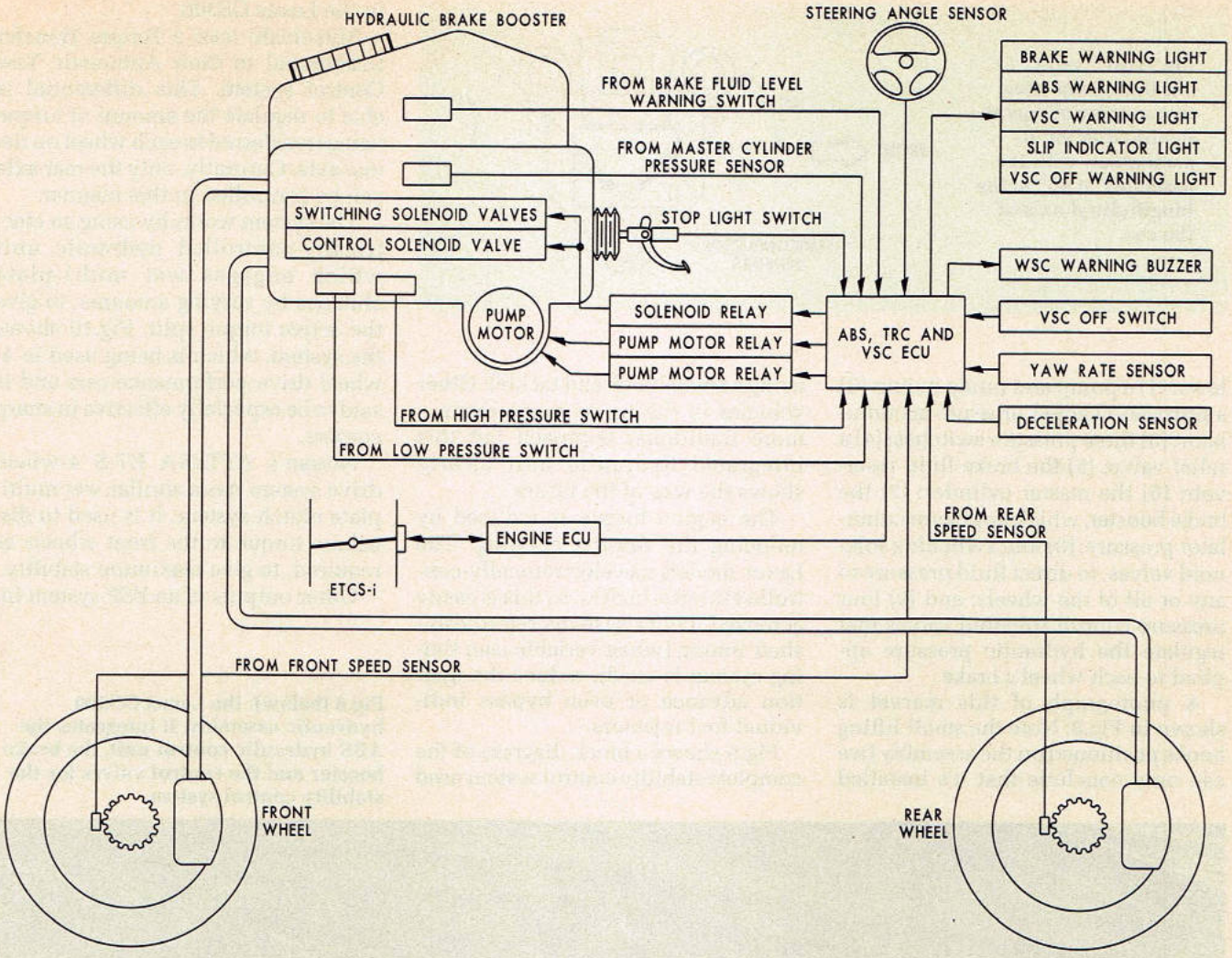


Fig.9: the Lexus GS300 stability control system. Inputs include wheel speeds, steering angle, deceleration and yaw rate. As indicated on the diagram, the same system is used for anti-lock brakes, traction control and vehicle stability control purposes.

clude self-diagnostic codes, a dash light (or gauge) to warn the driver when the system has activated, and another warning light to indicate that the system is inoperative.

Control strategies

Designing input sensors and output actuators for an ESP system is relatively straightforward but that doesn't apply when it comes to writing the software. Developing ESP control algorithms that work effectively in all situations is apparently quite difficult. In fact, some systems have quite different software, depending on the market that the car is aimed at.

Delphi, for example, use a different approach in the rear-wheel drive Chevrolet Corvette sports car to that used on several front-wheel drive Cadillac models. As with suspension tuning, what is best for one market sector is not necessarily best for another. That also implies another thing: when ESP systems become common, look out for "hot" programs that will be available on the aftermarket!

When a vehicle is understeering, braking of the inside rear wheel substantially reduces the amount of understeer that occurs. This can be easily understood if you again look at Fig.1. The vehicle is attempting to negotiate a righthand bend but the front of the car is sliding wide. If the righthand rear wheel was slowed while the other wheels continued to turn at their normal rate, the car would attempt to pivot around this wheel to the right. This would allow the car to successfully negotiate the bend in the road, instead of understeering off the road to the left.

In the rear-wheel drive Lexus cars, both rear wheels are braked and the engine torque output is reduced – see Fig.11. Toyota presumably adopted this approach because the car is designed to initially understeer if the cornering speed is too great. Simply slowing the car thus provides the required reduced understeer. Research from Delphi has shown that braking the inside front wheel can also significantly correct understeer but this applies only at small slip angles.

When a vehicle is oversteering, the most powerful corrective braking mechanism that can be employed is to brake the outside front wheel to near lock-up. In Fig.2, this would be the front lefthand wheel. If this wheel is braked but the others continue at normal speed, the car would attempt to pivot around to the left, thereby reducing the amount of oversteer.

The Lexus system does just this but it's not always quite that simple. At times, the Lexus also brakes the rear wheels during oversteer. This is likely to occur (in conjunction with a reduction in engine torque) when too much throttle is being applied.

While the yaw change that occurs with the slowing of a single wheel is the major corrective mechanism, another factor also has a significant affect. Earlier, it was stated that the grip of a tyre depends on both the cornering and the longitudinal loads placed on it. When an ESP system is activated, the car is at the limits of adhesion and then one wheel is suddenly braked! The braked tyre will thus slide sideways more easily than it did before the braking loads were imposed.

Let's now take another look at the oversteering vehicle in Fig.12. When the front lefthand wheel is braked, its lateral grip is also reduced. This means that the car will have less front-end grip and so the front of the car will start to move to the left – ie, in the same direction that the back is heading! So this effect also acts to decrease oversteer.

In an active 4-wheel drive car, the control strategy is based on reducing the amount of torque that's transferred to the end of the car that's sliding. For example, the Nissan Skyline GT-R is a rear-wheel drive car for most of the time. However, if power oversteer occurs during cornering, torque is transferred to the front wheels, thereby reducing the torque load on the rear tyres and also pulling the car in the steered direction. Some forms of the Nissan system do not use a yaw sensor, the torque split control being based only on the inputs received from accelerometers, wheel-speed sensors and the throttle position.

With 2-wheel drive cars, a typical control algorithm consists of the following steps:

(1) Calculate the desired values of vehicle yaw rate and slip angle, using the steering angle and vehicle speed;

(2) Using the difference between the desired and measured yaw rates and between the desired and estimated slip angles, determine the desired change in yaw that should be applied to the vehicle;

(3) Select the wheel(s) to which the brakes should be applied and determine the desired magnitude of braking pressure or brake slip.

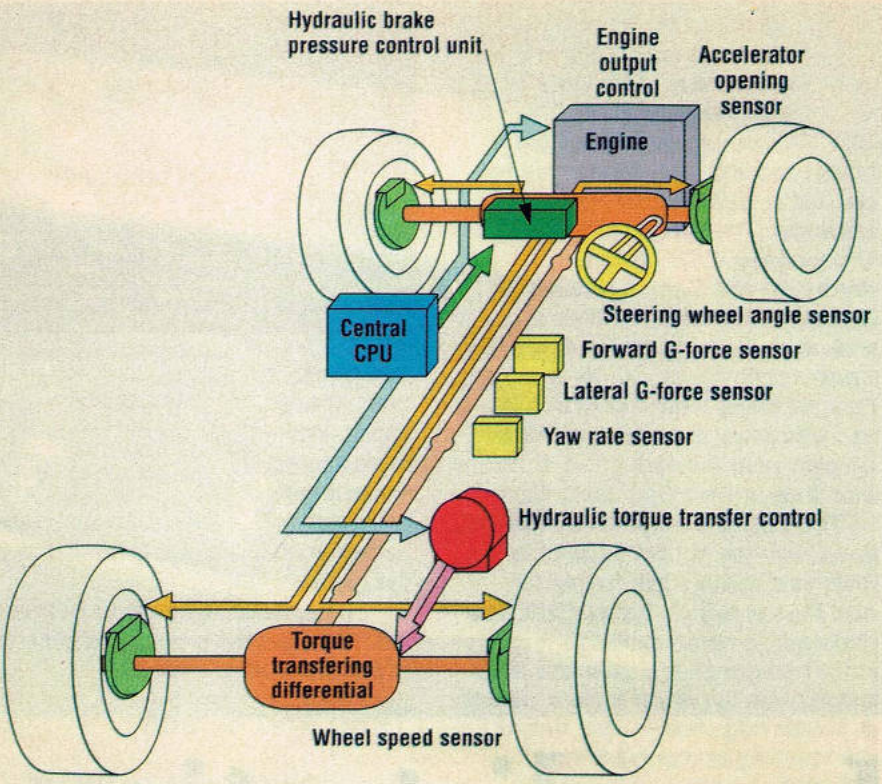


Fig.10: Mitsubishi's Active Yaw Control allows the amount of torque being channelled through each rear wheel to be varied by means of a Torque Transfer Differential.

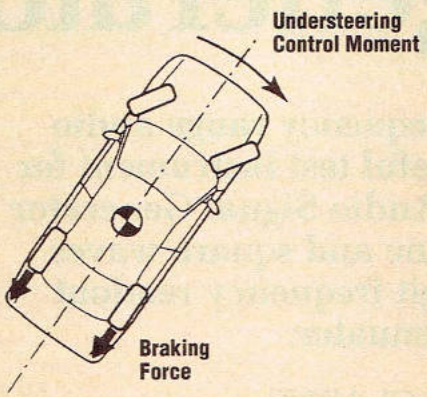


Fig.11: the Lexus system brakes both rear wheels to control understeer. Other systems brake just the inside rear wheel, creating a correcting yaw moment.

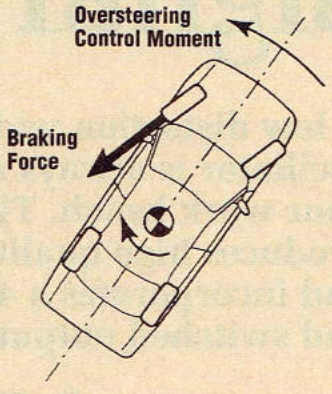


Fig.12: oversteer in the Lexus is controlled by braking the outside front wheel (car shown here making a right turn).

Closed loop control can be used during braking so that maximum retardation of the chosen wheel occurs. This prevents the need for an estimation of the surface coefficient of friction.

The major parts suppliers to vehicle manufacturers have stated quite clearly that adding an ESP system to a car already equipped with ABS can be done quite cheaply. That makes it very likely that stability control technology will find its way into a wide range of cars in the near future. **SC**

Low distortion audio signal generator; Pt.1

A low distortion wide frequency range audio oscillator is always a useful test instrument for your work bench. This Audio Signal Generator produces high quality sine and square waves and incorporates a 4-digit frequency readout and switched output attenuator.

By JOHN CLARKE

If you're an enthusiast who likes to dabble with audio equipment, you won't get too far unless you have a high-quality audio signal generator and preferably, an AC Millivoltmeter to go with it. We published an AC Millivoltmeter in the October & November 1998 issues and now we present a matching Audio Signal Generator.

This completely new audio signal generator effectively supersedes both the Digital Sine-Square Generator from the July 1990 issue of SILICON CHIP and the High Quality Audio Oscillator from January 1990 issue. While the new generator does not have the ultra-low distortion of the January 1990 circuit, it is much simpler in its range and frequency switching and it actually has better distortion below 100Hz. As well, the new design is considerably simpler in construction.

Operating features

As you can see from the photos, the new Audio Signal Generator comes in a standard plastic instrument case and has four knobs and a 4-digit display on the front panel. On the lefthand side are the frequency controls: a 4-position range switch and a variable frequency knob. Then there are the amplitude controls which comprise the 8-position attenuator and the vernier control knob.

There are three toggle switches, one to select sine or square wave output,

Features

- Sine or square wave output
- 10Hz-100kHz range
- Fast settling time
- Digital frequency readout
- Stepped attenuator with fine adjustment
- Sync output for oscilloscope
- Display off switch

one to ground or "float" the instrument and one to turn off the frequency display. This last-mentioned switch is included so that when you are doing critical measurements with the oscillator, you can switch off the display and thereby eliminate any multiplex hash from the sinewave signal.

Finally, there are two BNC sockets, one for the main sine/square output and one for the sync output to an oscilloscope.

Settling time

Where this new design is notably superior to our previous high quality design is in settling time. Many very low distortion audio oscillators suffer from a long settling time whereby the output amplitude bounces badly after each change in frequency. Our new signal generator has a negligible settling time and the frequency control knob can be swept rapidly from one extreme to the other on the three lowest ranges without any level change occurring.

On the highest frequency range, there is a short duration dip in output level at around 60kHz if the control knob is swept too quickly.

The new Audio Signal Generator is also far superior in its output level flatness versus frequency compared to both previous oscillators. Output level flatness is of particular importance in an audio signal generator. If you wish to make measurements of an amplifier's frequency response from 20Hz to beyond 20kHz, any variation in level from the generator will also be measured at the amplifier output. This will lead to an incorrect amplifier response measurement. Similarly when checking a filter, any generator level variation will be reflected in the filter's response.

Sine & square output

This latest Audio Signal Generator can produce either a sine or square wave output with the latter being particularly useful for measuring the slew rate of amplifiers. The 33ns rise and fall times of the square wave output correspond to a 300V/µs slew rate for a 1V signal. This is more than adequate to check any audio amplifier's response to square waves.

Also included is a sync output which can be used to lock an oscilloscope to the output waveform. This output is constant in level (280mV RMS), regardless of the output level set on the attenuator.

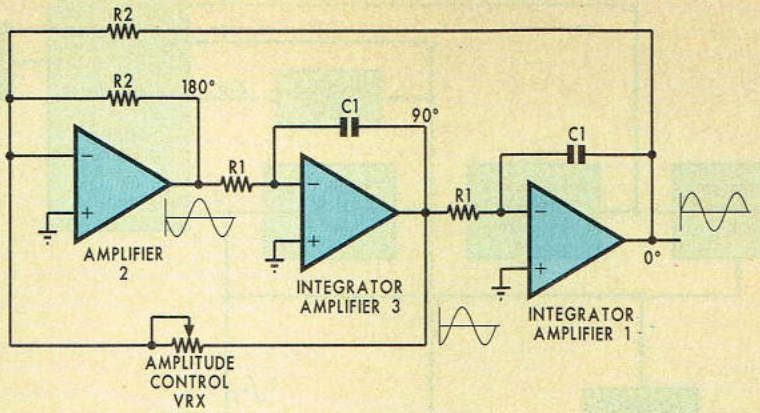


Fig.1: the "state variable oscillator" comprises three op amps, two of which are configured as integrators and the third as an inverter.

The output attenuator provides eight steps, ranging from 3.16V down to 1mV, in 10dB steps. There is also a variable control (vernier) which can reduce the output level to zero.

The output frequency is displayed on a 4-digit LED readout. It has a relatively fast update time so that the output can be varied quickly using the frequency adjust control without having to wait for the display to catch up.

State variable oscillator

Our new Audio Signal Generator is based on a "state variable oscillator". As shown in Fig.1, it comprises three op amps, two of which are configured as integrators and the third as an inverter. Each integrator has a frequency response which reduces with increasing frequency at 6dB/octave (10dB/decade) and they each introduce a 90-degree lagging phase shift.

We have shown the output of op amp 1 as being the reference waveform with 0° phase shift. Its output is coupled to the inverting input of op amp 2 via resistor R2. Op amp 2's gain is -1, as set by the input and feedback resistors which have the same value (R2). The negative gain figure comes about because op amp 2 is an inverter. The output of op amp 2 is 180° out of phase to its input. Op amp 3 is an integrator producing a 90° phase shift and this is followed by op amp 1 producing another 90° phase shift. The phase changes through three op amps add up to 360° and so we have the perfect recipe for an oscillator.

The oscilloscope waveforms of Fig.2

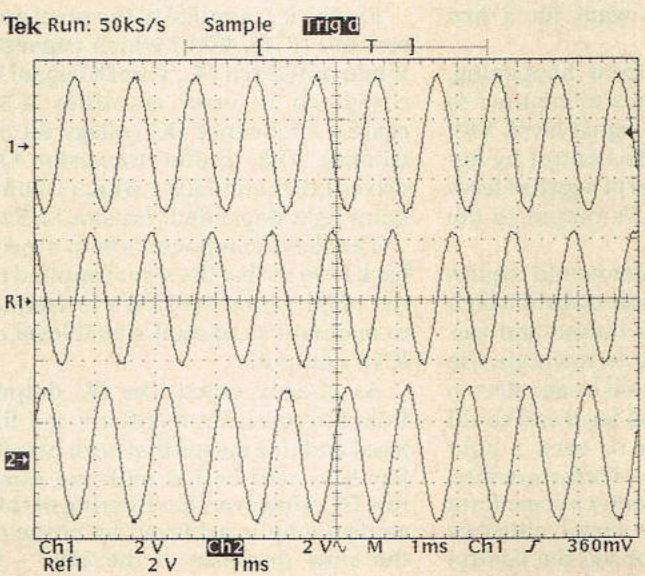


Fig.2: these waveforms demonstrate the operation of the state variable oscillator. The top trace shows the output of op amp 1 while the lower trace is op amp 2. Note that the lower trace is 180° out of phase to the top trace. The centre trace, op amp 3, lags behind the lower trace by 90°.

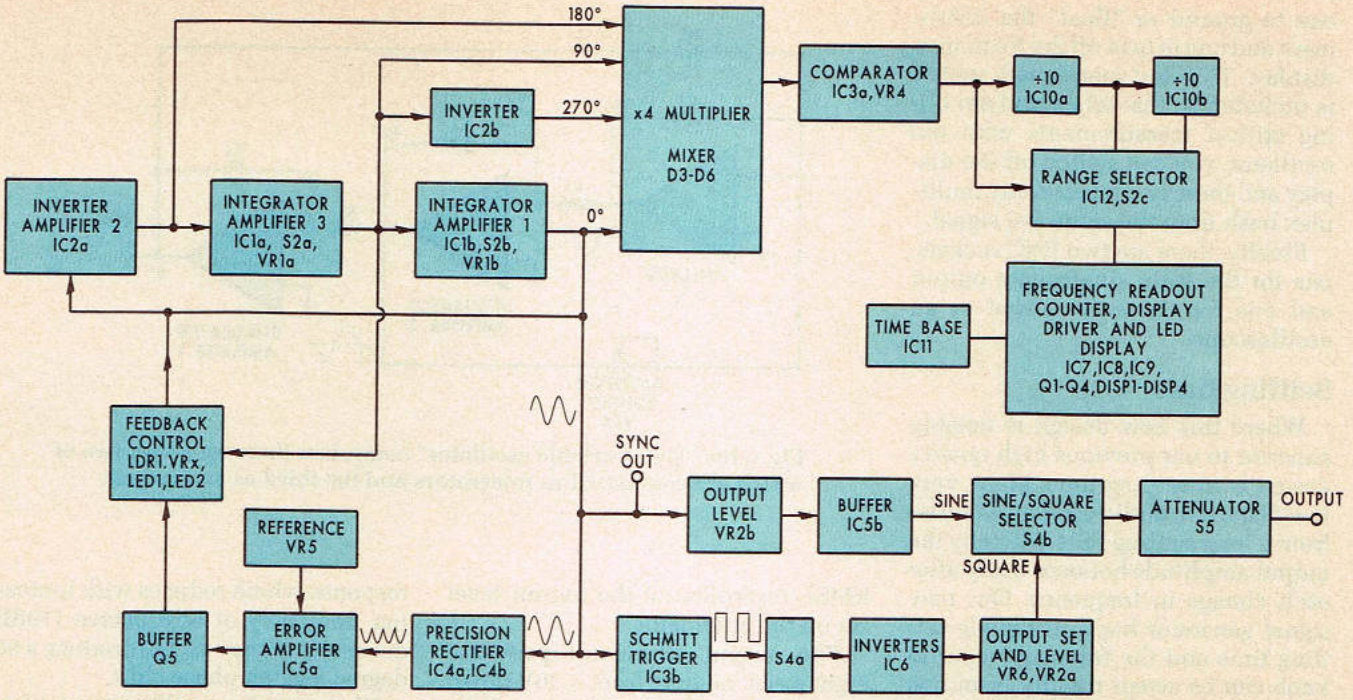


Fig.3: the block diagram shows that the state variable oscillator of Fig.1 needs a lot more circuitry for a practical instrument. The frequency of the state variable oscillator is multiplied by four to drive the digital counter circuitry.

show how the circuit oscillates. The top trace shows the output of op amp 1 while the lower trace is op amp 2. Note that the lower trace is 180° out of phase compared to the top trace. The centre trace, from op amp 3, lags behind the lower trace by 90°.

The frequency of oscillation is equal to $1/(2\pi R1.C1)$, provided that op amp 2 has a gain of -1. An oscillator of this type will produce an output level which is only limited by the amount of peak-to-peak swing from the amplifiers. In other words, the output will rise until the circuit clips, which is hardly what we want for a low distortion design.

To prevent this from happening, some form of feedback is required to maintain a constant signal level. VRx introduces amplitude control by applying a small amount of negative feedback from op amp 3's output to the input of op amp 2.

A practical oscillator would require an automatic amplitude control which monitors op amp 1's output and varies VRx accordingly to maintain the output level. VRx could be any device which can vary signal level and could be a FET, transistor or even a light dependent resistor. Unfortunately, these devices all introduce some form of distortion into the signal, either by their non-linearity or via the control circuitry which drives them. Interestingly, some of this distortion is then reduced via the 6dB/octave low pass rolloff from op amp 3 to op amp 1.

Block diagram

The complete block diagram for the Audio Signal Generator is shown in Fig.3. The oscillator itself comprises op amps IC1a, IC1b and IC2a, with the integrator components VR1a & VR1b and capacitors selected by 2-pole switch S2a & S2b. The sinewave output of IC1b is applied to several sections of the block diagram.

Firstly, it is applied to the precision rectifier (IC4a, IC4b) which converts it into unfiltered DC. This DC signal is compared in error amplifier IC5a against a reference DC voltage set by trimpot VR5. Buffer transistor Q5 drives LED1 and LED 2 which illuminates light dependent resistor LDR1.

The above components form a feedback loop so that the signal applied to the LEDs varies the LDR's resistance to maintain a constant signal level at IC1b's output.

As already noted, the DC output from the precision rectifier is not filtered and this means that error amplifier IC5a will be fed with the same raw DC. However, the filtering of this control loop is achieved by virtue of the slow response of the LDR – it ignores the harmonics in the signal.

The waveforms of Fig.4 show the action of the control loop. The top trace is the output of IC1b, while the middle trace shows the rectified signal applied to error amplifier IC5a.

The third trace shows the drive to the LEDs. These are short pulses which occur at the peak of the sine waveform.

As well as driving the precision rectifier, IC1b's output is applied to the output level control VR2b and the sync output. VR2b is buffered by op amp IC5b which drives the attenuator switch S5. The attenuator provides 10dB steps in signal levels from 3.16V to 1mV.

IC1b also drives the Schmitt trigger IC3b which produces a square wave output which is fed to paralleled CMOS inverters in IC6. These give the square wave signal very fast rise and fall times.

Fig.5 shows the square wave rise and fall times at 33ns and 30ns, respectively.

Frequency multiplier

We now come to the frequency display part of the block diagram and there are a few unconventional features in this section.

First, there is the frequency multiplier. This uses a diode mixer to add

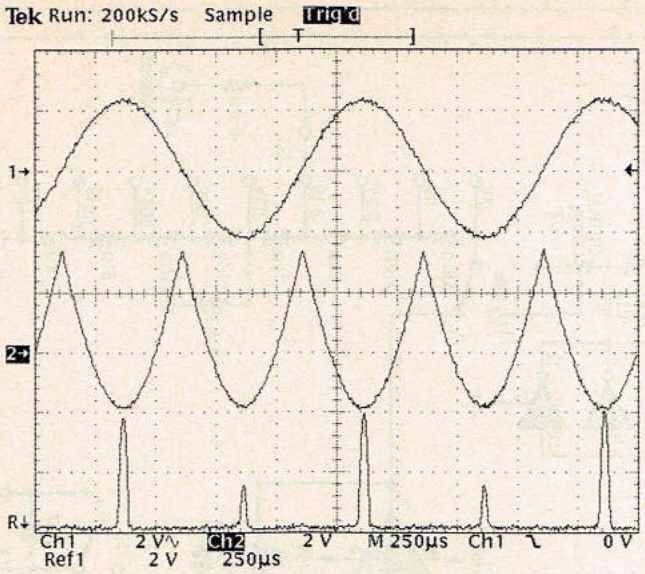


Fig.4: these waveforms show the action of the control loop for the state variable oscillator. The top trace is the output of IC1b while the middle trace shows the precision rectified signal applied to error amplifier IC5a. The third trace shows the drive to LEDs 1 & 2

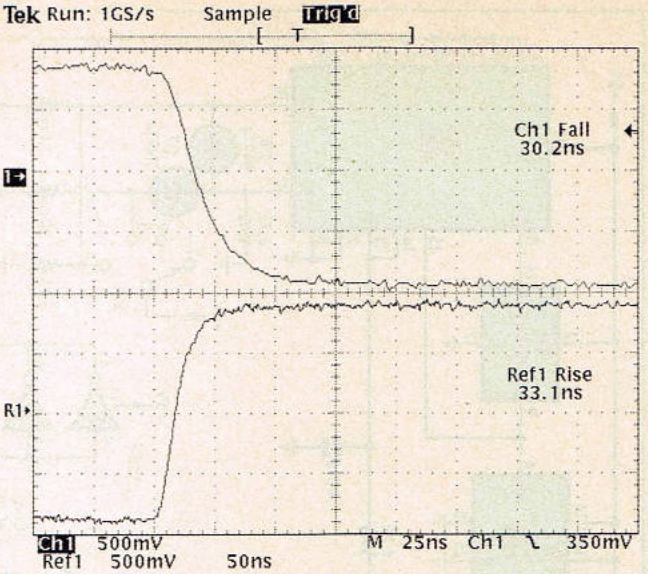


Fig.5: these are the square wave rise and fall times.

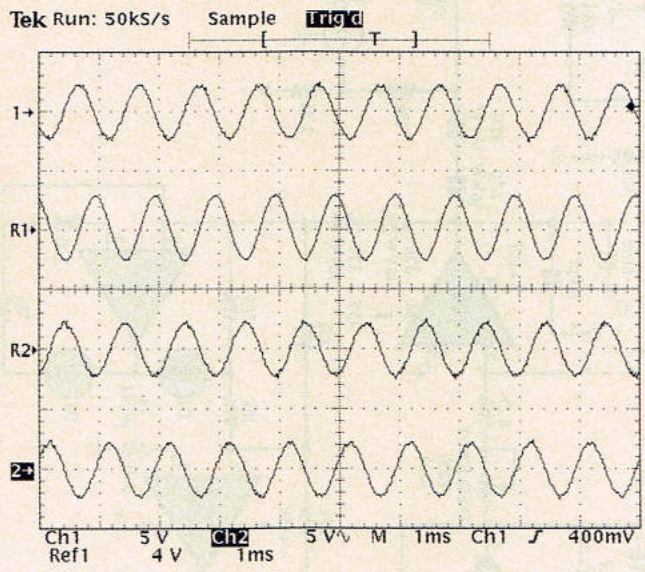


Fig.6: these four waveforms are added together in a diode mixer to obtain a frequency multiplication of four.

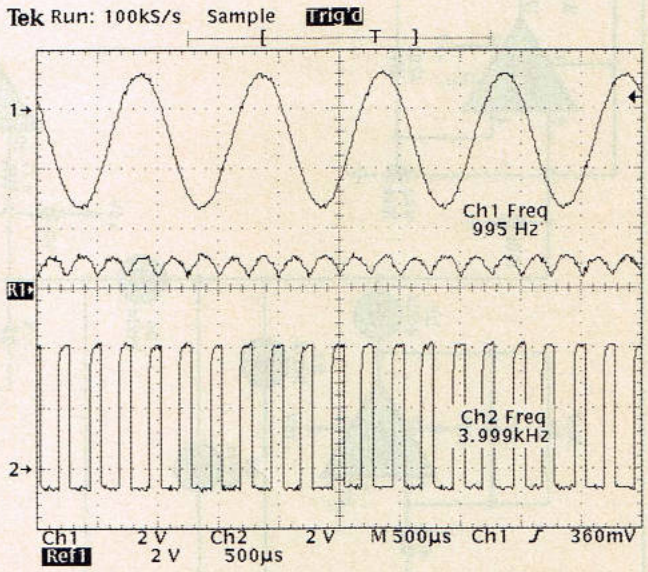


Fig.7: these waveforms shows the action of the diode frequency multiplier. The top trace is the output of IC1b, the middle trace is the mixer output applied to IC3a and the bottom trace is the output of IC3a.

the signal outputs of IC1a, IC1b, IC2a and IC2b. These signals are shown in the oscilloscope waveforms of Fig.6.

The output of the diode mixer is a waveform with a fundamental frequency which is four times the sinewave at IC1b's output. Comparator IC3a squares the multiplier output, as shown in Fig.7. The top trace is the output of IC1b, the middle trace is the mixer output applied to IC3a and the bottom trace is the output of IC3a.

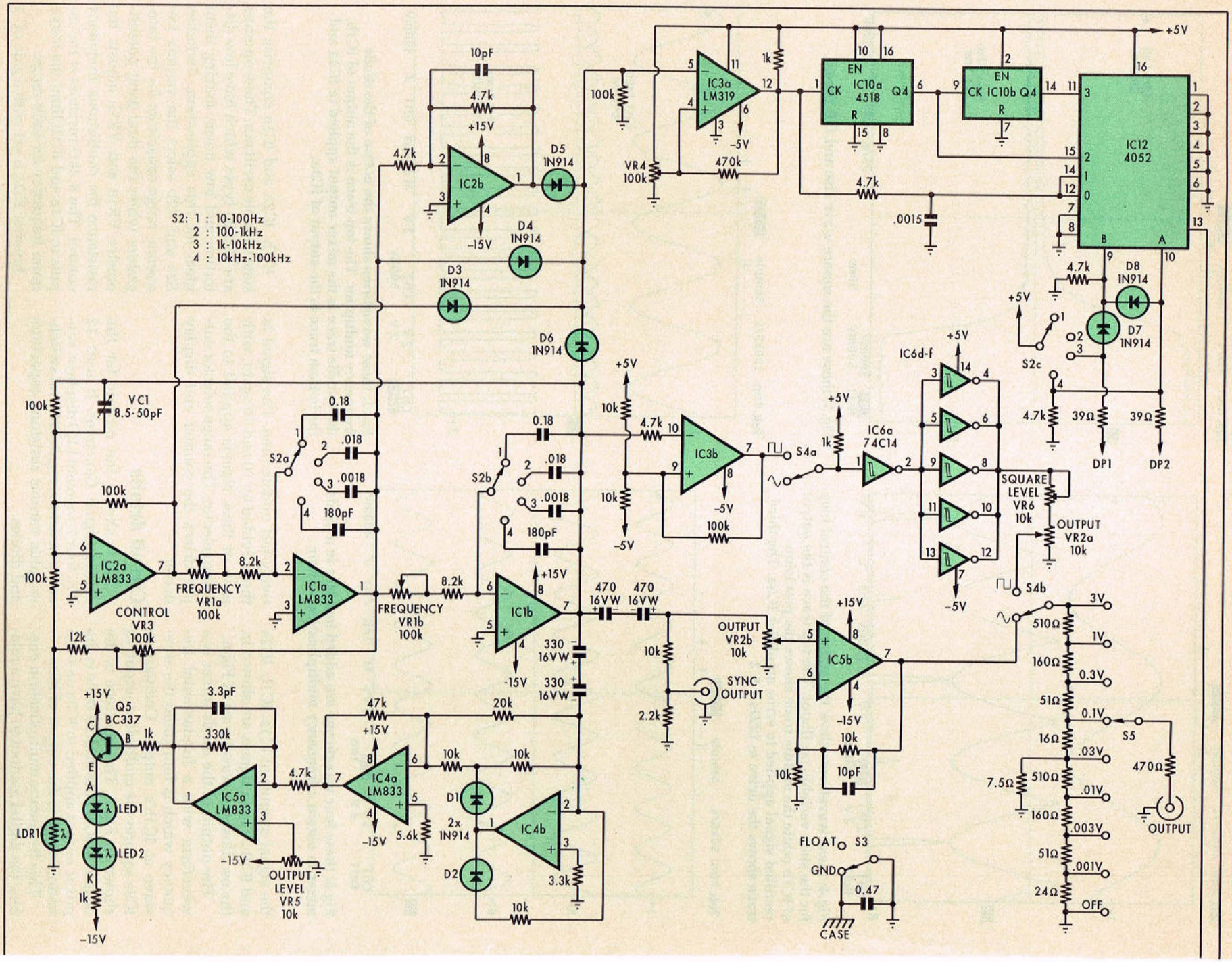
This frequency multiplication enables the digital readout to have a relatively fast update time. The signal is then divided by 10 and 10 again, with each of these signals applied to the range selector. The range selector output drives the counter and display driver.

Circuit details

Fig.8 shows the circuit for the Audio Signal Generator. It uses 12 ICs, four 7-segment LED displays, several transistors, regulators and switches, plus various resistors, capacitors and diodes.

IC1b, IC2a and IC1a comprise the state variable oscillator. These op amps are LM833 types which have low distortion and low noise, making them ideal for this application. Switches S2a and S2b select the various frequency range capacitors for the integrators while the dual-gang potentiometer VR1a and VR1b adjusts the resistance for continuous frequency control. The 8.2kΩ resistors at the inputs to IC1a and IC1b limit the maximum frequency for each range.

Inverter IC2a is set with a gain of -1


S2: 1 : 10-100Hz
2 : 100-1kHz
3 : 1k-10kHz
4 : 10kHz-100kHz
+5V
IC12 4052
IC10a 4518
IC10b
IC3a LM319
IC3b
IC6a 74C14
IC6d-f
IC2a LM833
IC2b
IC1a LM833
IC1b
IC4a LM833
IC5a LM833
IC5b
IC4b
Q5 BC337
LED1
LED2
LDR1
VC1 8.5-50pF
CONTROL VR3 100k
FREQUENCY VR1a 100k
FREQUENCY VR1b 100k
OUTPUT LEVEL VR5 10k
SQUARE LEVEL VR6 10k
OUTPUT VR2a 10k
OUTPUT VR2b 10k
SYNC OUTPUT
D1 2x 1N914
D2
D3 1N914
D4 1N914
D5 1N914
D6 1N914
D7 1N914
D8 1N914
S2a
S2b
S2c
S3
S4a
S4b
S5
FLOAT
GND
CASE
OFF
OUTPUT
DP1
DP2

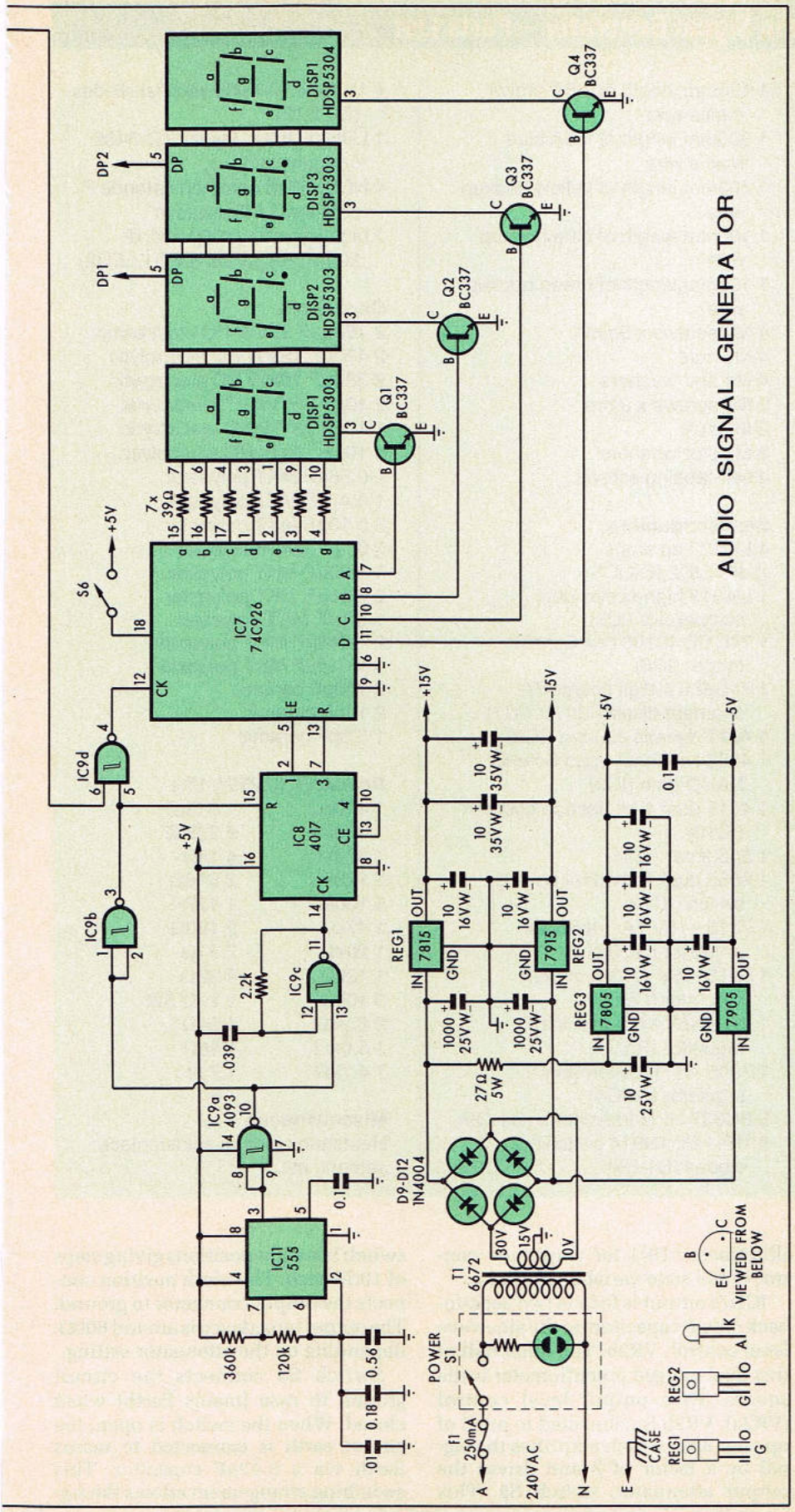


Fig.8: the circuit can be broken down into a number of sections. In the middle is the state variable oscillator and the square wave driver. At the top is the frequency multiplier and at the bottom is the frequency counter circuitry.

using the 100kΩ resistors from pin 6 to pin 7 and the input resistor to pin 6 from the output of IC1b. Trimmer capacitor VC1 is used to compensate for phase shifts in the oscillator at high frequencies. It is adjusted so that the oscillator does not become uncontrollable at the highest frequencies.

The precision full wave rectifier comprises op amps IC4a and IC4b together with diodes D1 and D2 and associated resistors. When the input signal goes negative, IC4b's output goes high and the gain, set by the 10kΩ input and feedback resistors, is -1. This signal is seen at the cathode of D1 and is coupled to the inverting input of IC4a via the 10kΩ resistor. Gain is set for IC4a by the 10kΩ input resistor and the 47kΩ feedback resistor at -4.7. Overall gain for the input signal is therefore (-1 x -4.7) = +4.7.

Note, however, that there is an extra path for the input signal via the 20kΩ resistor at pin 6 of IC4a. This produces a positive signal at the output of IC4a with a gain of 47kΩ divided by the 20kΩ resistor or -2.35. Adding the two gains gives us +2.35.

For positive signals the output of IC4b is clamped due to the conduction of D2. Signal then passes via the 20kΩ resistor connected to pin 6 of IC4a. IC4a inverts the signal and provides gain of -2.35. Since the input signal is positive the signal at pin 7 of IC4a is negative.

Thus for positive input signals the output at IC4a is negative, with a gain of -2.35. For negative signals the output of IC4a is also negative, with a gain of 2.35. So a full-wave rectifier results.

Note that the output of IC1b is AC-coupled to the precision rectifier, to prevent any DC offset in the signal from affecting the rectifier operation.

Error amplifier

Op amp IC5a is the error amplifier. It compares the precision rectifier output with the reference voltage set at its pin 3 input. This reference voltage

Audio Signal Generator – Parts List

1 PC board, code 01402991, 122 x 141mm
1 PC board code, 01402992, 210 x 73mm
1 front panel label, 249 x 76mm
1 plastic case, 256 x 190 x 84mm
2 aluminium panels, 249 x 76mm
1 red transparent Perspex sheet, 59 x 21 x 2.5mm
1 6672 30V centre-tapped mains transformer (T1)
1 IEC mains panel socket with fuseholder
1 insulating boot for IEC socket
1 250mA 2AG 250VAC fuse (F1)
1 IEC mains cord
1 SPDT mains rocker switch with neon indicator (S1)
1 3-pole 4-position rotary switch (S2)
2 SPDT toggle switches (S3,S6)
1 DPDT toggle switch (S4)
1 single-pole 12-position rotary switch (S5)
1 100kΩ 24mm dual-gang linear pot (VR1)
1 10kΩ 24mm dual-gang linear pot (VR2)
1 100kΩ horizontal trimpot (VR3)
3 10kΩ horizontal trimpots (VR4-VR6)
1 8.5-50pF trimmer capacitor (VC1)
2 BNC panel sockets with insulating kits
1 TO-220 heatsink, 28 x 25 x 35mm
4 19mm knobs
21 PC stakes
1 40-way pin header (broken into groups of five)
1 600mm length of 0.7mm tinned copper wire
1 300mm length of 7.5A green/yellow 250VAC rated wire
1 400mm length of 7.5A brown mains wire
1 300mm length of 7.5A blue mains wire
1 100mm length of yellow hookup wire
1 100mm length of blue hookup wire
1 100mm length of green hookup wire
4 M4 screws x 9mm
4 M4 nuts
4 M4 star washers
2 M3 screws x 9mm
2 M3 nuts
2 M3 star washers
4 self-tapping screws

Semiconductors
4 LM833 op amps (IC1,IC2,IC4,IC5)
1 LM319 high-speed dual comparator (IC3)
1 74C14, 40106 hex Schmitt trigger (IC6)
1 74C926 4-digit counter/7-segment display driver (IC7)
1 4017 decade counter (IC8)
1 4093 two-input quad Schmitt NAND gate (IC9)
1 4518 dual 4-bit decade counter (IC10)
1 555 timer (IC11)
1 4052 dual 4-channel analog switch (IC12)
1 7815 +15V 1A 3-terminal regulator (REG1)
1 7915 -15V 1A 3-terminal regulator (REG2)
1 7805 +5V 1A 3-terminal regulator (REG3)
1 7905 -5V 1A 3-terminal regulator (REG4)
5 BC337 NPN transistors (Q1-Q5)
8 1N4148, 1N914 switching diodes (D1-D8)
4 1N4004 1A 400V rectifier diodes (D9-D12)
1 LDR (LDR1), Jaycar RD-3485 or equivalent
4 HDSP5303 common cathode 7-segment LED displays
2 high intensity (1000mcd @ 20mA) red LEDs (LED1,LED2)

Capacitors
2 1000µF 25VW PC electrolytic
2 470µF 16VW PC electrolytic
2 330µF 16VW PC electrolytic
2 10µF 35VW PC electrolytic
1 10µF 25VW PC electrolytic
6 10µF 16VW PC electrolytic
1 0.56µF MKT polyester
1 0.47µF MKT polyester
3 0.18µF MKT polyester
2 0.1µF MKT polyester
1 .039µF MKT polyester
2 .018µF MKT polyester
1 .01µF MKT polyester
2 .0018µF MKT polyester
1 .0015µF MKT polyester
2 180pF ceramic
2 10pF ceramic
1 3.3pF ceramic

Resistors (0.25W, 1%)

1 470kΩ	1 3.3kΩ
1 360kΩ	2 2.2kΩ
1 330kΩ	4 1kΩ
1 120kΩ	2 510Ω
5 100kΩ	1 470Ω
1 47kΩ	2 160Ω
1 20kΩ	2 51Ω
1 12kΩ	9 39Ω
8 10kΩ	1 27Ω 5W
2 8.2kΩ	1 24Ω
1 5.6kΩ	1 16Ω
7 4.7kΩ	1 7.5Ω

Miscellaneous
Heatshrink tubing, solder, black sealant, etc.

sets the sinewave output level and is adjusted with VR5. The error amplifier has a gain of about 70, as set by the 330kΩ resistor and 4.7kΩ resistor at pin 2. The 3.3pF capacitor across the 330kΩ resistor provides a high frequency rolloff of 146kHz and prevents any tendency to spurious oscillation.

IC5a's output is buffered by transistor Q5, connected as an emitter follower. It drives LED1 and LED2 and these illuminate LDR1 for amplitude control of the state variable oscillator.

IC1b's output is fed via two back-to-back 470µF capacitors to the sinewave level control, VR2b. The other half of this dual-ganged potentiometer is the square wave output level control (VR2a). VR2b is connected to pin 5 of op amp IC5b which amplifies the signal by a factor of 2 and drives the output attenuator, switch S5. This switch has eight positions giving steps of 10dB each. The ninth position connects the output connector to ground. The output impedance is around 600Ω, depending on the attenuator setting.

Switch S3 connects the circuit ground to case (mains Earth) when closed. When the switch is open, the circuit earth is connected to mains Earth via a 0.47µF capacitor. This switching arrangement allows the sig-

Specifications

Frequency range: 10Hz-100kHz in four ranges

Total harmonic distortion (THD): 0.02% at 3V out from 20Hz to 2kHz with frequency display off; (.03% with display on); .04% at 10kHz (display off) and 0.1% at 100kHz

Output flatness: ±0.1dB from 20Hz to 100kHz; ±0.35dB from 10Hz to 100kHz.

Maximum output: 3.16V RMS on sine wave; 3.16V peak on square wave

Attenuator: seven steps in -10dB increments plus vernier

Attenuator accuracy: within ±0.5dB for all ranges

Output impedance: 600Ω (nominal)

Sync output: 280mV RMS sine wave

Square wave rise and fall times: typically <33ns

Frequency readout resolution: 1Hz for 10-1000Hz ranges, 10Hz for 1-10kHz range and 100Hz for 10k-100kHz range

Frequency accuracy: typically less than 5% uncalibrated (can be calibrated)

Frequency readout update time: 312ms (3.2 per second)

nal generator to be earthed when necessary or disconnected if a hum loop is evident.

Square wave generation

To obtain a square wave, IC1b's output is applied to comparator IC3b which is connected as a Schmitt trigger with positive hysteresis applied between its pin 7 output and pin 9 via a 100kΩ resistor. Pin 9 is also tied to the midpoint of the ±5V supplies via 10kΩ resistors. The positive hysteresis sets the switching thresholds for pin 10 at +0.24V and -0.24V respectively. So when the input goes above +0.24V, pin 7 goes low and when the input goes below -0.24V, pin 7 goes high. Note that IC3b's output is an open collector stage which requires a pullup resistor. This resistor is only connected when switch S4a is selected for square wave output.

The output from IC3b is further squared with Schmitt trigger inverter IC6a which drives the five paralleled inverters IC6b-IC6f. They drive trimpot VR6 and dual-gang pot VR2a.

Frequency multiplier

As discussed previously, diodes D3, D4, D5 & D6 mix the sinewave outputs from IC2a, IC1a, IC2b and IC1b. The resultant waveform is squared up in Schmitt trigger IC3a. Because the output of IC3a is a single open-collector NPN transistor and its load resistor is connected to the +5V rail, and the control pin (pin 3) connected to ground, the output swing is limited to 0V and +5V which is what is needed for the following divider stages.

The output of IC3a connects to the 4518 dual BCD counter, IC10. The two counters produce a total division of 100 at pin 14. The output of IC3a, the Q4 output from IC10a and the Q4 output from IC10b are all connected to IC12, a 4052 analog switch, and this acts as the range switch for the display. Depending on the voltages fed to its inputs at pins 9 & 10 from switch S2c, IC12 selects one of the inputs and feeds it out at pin 13.

When range switch S2c is in positions 1 & 2, pins 9 & 10 of IC12 are tied low via 4.7kΩ resistors. This selects the pin 12 input from IC3a. When S2c is in position 3, diode D7 pulls pin 9 of IC12 to the +5V supply and so IC12 selects the signal at pin 15 which is the divide-by-10 signal from IC10a. Position 3 of S2c also applies 5V to the decimal point (DP1) of display DISP2 via a 39Ω resistor.

Position 4 of S2c pulls pin 10 of IC12 high and pin 9 high via diode D8. This selects the pin 11 input of IC12 which is the divide-by-100 signal from IC10b. Decimal point DP2 is now selected and driven via a 39Ω resistor on DISP3.

The signal from pin 13 of IC12 is applied to the pin 6 input of Schmitt

Huge range of VIDEO

Processors, Stabilisers, Mixers, Editors, TBC's, Standards Converters, Switchers, Amplifiers, connectors, cables, adaptors, kits. PC editing cards & software:- FAST DV, AV Master plus, Miro DV300, DC30+, DPS Spark, Edit Bay, etc. SCSI cards & drives. PC Converters & Genlocks. Call for prices and information or ...

Check our website for latest prices and
MONTHLY SPECIALS
http://www.questronix.com.au/~questav

You can fax, post, phone or email your order.
We accept AMEX, VISA, Master & Bank cards, cash and direct deposit, but not cheques.
Ex-tax sales available to exempt buyers.
Prompt delivery within Australia & overseas.

QUESTRONIX

2/1 Leonard Street, HORNSBY, NSW, 2077
P O Box 548, WAHROONGA, NSW, 2076
Fax (02) 9477 3681 **Ph. (02) 9477 3596**
Email questav@questronix.com.au
Visitors and demo's by appointment only.

VCC3010 *High Resolution Picture Corrector*

Adjust RGB/ Contrast/ Brightness/ Saturation/ Detail etc. 4 i/p Audio & Video selectors. Fade to black. Use Y/C & Comp. i/p's & o/p's in any combination.

The ultimate stabiliser
E-D TBC/ Enhancer
Totally eliminates 'piggy-back' signals!

Full-frame 4:2:2 digital TBC. Adjust RGB, gain, black level, chroma, colour shift, etc. Freeze, enhance, bypass, four memories for settings, built-in Bars, Black Burst, YUV& RGB o/p's, etc.

P.C.B. Makers !

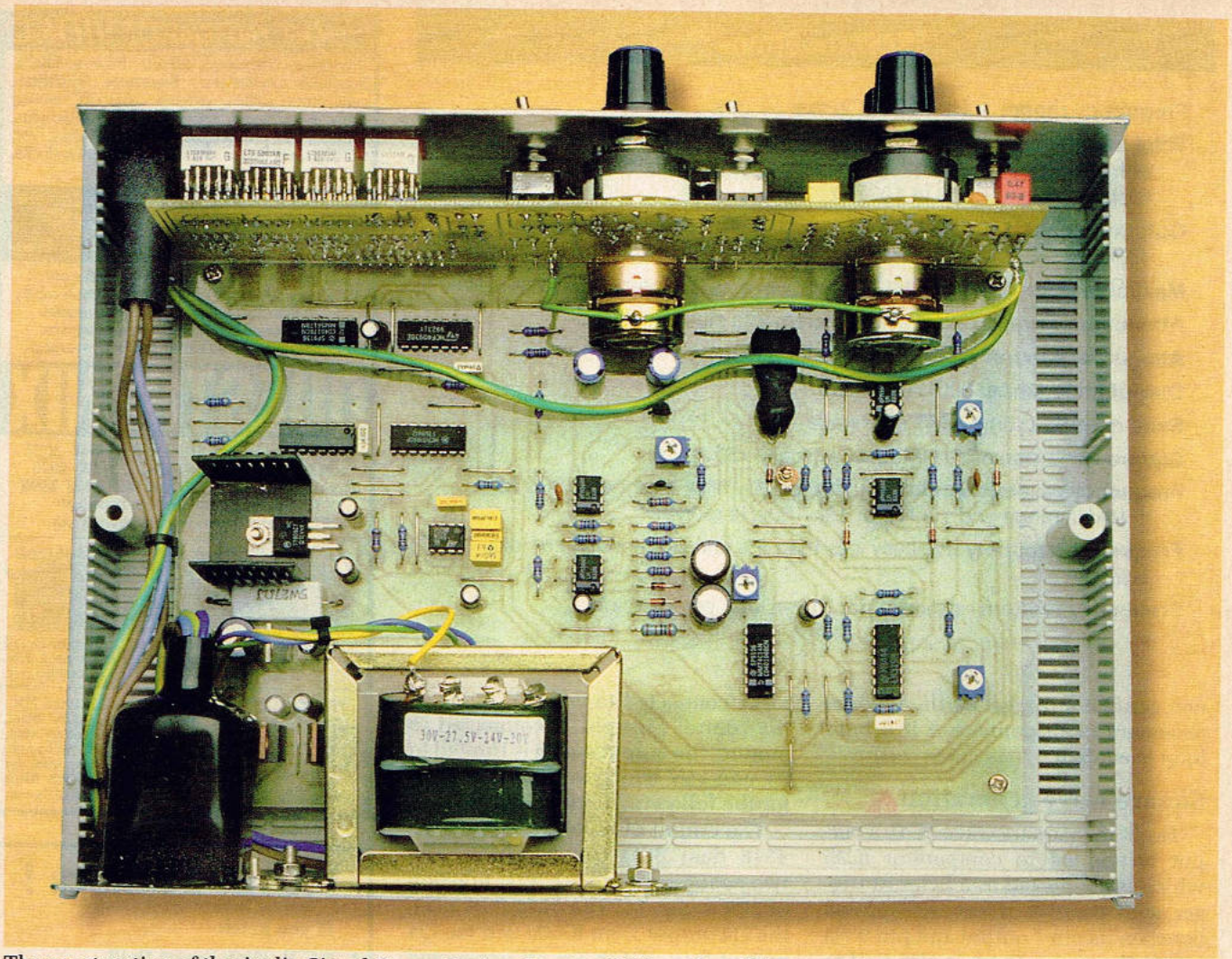
If you need:

- **P.C.B. High Speed Drill**
- **P.C.B. Guillotine**
- **P.C.B. Material – Negative or Positive acting**
- **Light Box – Single or Double Sided – Large or Small**
- **Etch Tank – Bubble or Circulating – Large or Small**
- **U.V. Sensitive film for Negatives**
- **Electronic Components and Equipment for TAFEs, Colleges and Schools**
- FREE ADVICE ON ANY OF OUR PRODUCTS FROM DEDICATED PEOPLE WITH HANDS-ON EXPERIENCE
- **Prompt and Economical Delivery**

KALEX

40 Wallis Ave E. Ivanhoe 3079
Ph (03) 9497 3422
FAX (03) 9499 2381

- **ALL MAJOR CREDIT CARDS ACCEPTED**



The construction of the Audio Signal Generator involves two PC boards, with very little else in the way of interconnecting wiring. We'll publish the full constructional details in Pt.2 next month.

NAND gate IC9d. The second input at pin 5 is under control from the time-base signal derived from IC11.

IC11 is a 555 timer which is connected in the astable (free running) mode. The capacitors at pins 2 & 6 are charged via the series 360kΩ and 120kΩ resistors and discharged via the 120kΩ resistor. The result is a pulse waveform at pin 3 which is high for 0.25 seconds and low for 62ms. This is inverted with IC9a and inverted again with IC9b. IC9b controls the pin 5 input to IC9d and this gates through the signal from pin 13 of IC12 to the clock input (pin 12) of counter IC7.

Each time pin 3 of IC11 goes low, pin 15 (Reset) of IC8 is pulled low via IC9b. Also the high output at pin 10 of IC9a allows oscillator IC9c to operate and it clocks IC8. This is a decade counter and it provides the latch enable (LE) and Reset signals for IC7. When pin 2 of IC8 goes high, it latches the counted signal in IC7 into the display. After that, pin 7 of IC8 resets IC7 for the next count cycle.

The latched count signal in IC7 is indicated on the 7-segment LED displays. IC7 drives the display in multiplex fashion via transistors Q1-Q4. This has the advantage of a reduced number of connections between the counter and the 7-segment displays but it does have the drawback of all multiplexed displays and that is increased "hash" on the supply rails. Inevitably, some of this hash finds its way into the audio output of the signal and to eliminate that problem we have included toggle switch S6 into the circuit.

S6 disconnects the +5V supply to pin 18 of IC7 and this turns off the displays. Note that the clock, LE and R signals are still be applied to IC7 even when the +5V rail is switched off. However, this will not cause damage to the counter IC.

Power supply

The power supply uses a fairly large power transformer and this is mainly required to satisfy the current drain of the 4-digit 7-segment LED display. The transformer secondary windings are connected as a 30V centre-tapped output to drive a bridge rectifier and two 1000µF filter capacitors. The resulting ±20V DC rails are applied to a +15V regulator (REG1) and a -15V regulator (REG2) and these supply the op amps. The +20V supply is also fed to a +5V regulator via a 27Ω dropping resistor while the -20V rail feeds a -5V regulator directly.

This completes the circuit description. Next month we will give the full constructional details. **SC**

SILICON CHIP

ORDER FORM

BACK ISSUES

MONTH	YEAR	MONTH	YEAR	PRICE EACH (includes p&p)	TOTAL
				Australia $A7.00; NZ $A8.00 (airmail); Elsewhere $A10 (airmail). Buy 10 or more and get a 10% discount. Note: Nov 87-Aug 88; Oct 88-Mar 89; June 89; Aug 89; Dec 89; May 90; Aug 91; Feb 92; July 92; Sept 92; Nov-Dec 92; & March 98 are sold out. All other issues are currently in stock.	$A

BINDERS

Please send me _____ SILICON CHIP binder(s) at $A12.95 + $5.00 p&p each (Australia only). Not available elsewhere. Buy five and get them postage free. $A

Subscribe & Get A 10% Discount On All Other Silicon Chip Merchandise

SUBSCRIPTIONS

❑ New subscription – month to start _____

❑ Renewal – Sub. No. _____ ❑ Gift subscription ☞

RATES (please tick one)	2 years (24 issues)	1 year (12 issues)
Australia	❑ $A112	❑ $A59
Australia with binder(s)**	❑ $A138	❑ $A72
New Zealand (airmail)	❑ $A145	❑ $A77
Overseas surface mail	❑ $A160	❑ $A85
Overseas airmail	❑ $A250	❑ $A125

** 1 binder with 1-year subscription; 2 binders with 2-year subscription

GIFT SUBSCRIPTION DETAILS

Month to start _____

Message _____

_____

_____

Gift for:
Name _____
(PLEASE PRINT)

Address _____

_____

State _____ Postcode _____

YOUR DETAILS

Your Name _____
(PLEASE PRINT)

Address _____

_____ Postcode _____

Daytime Phone No. _____ **Total Price $A** _____

❑ Cheque/Money Order ❑ Bankcard ❑ Visa Card ❑ Master Card

Card No. | | | | | | | | | | | | | | | | |

Signature

_____

Card expiry date _____/_____

Phone (02) 9979 5644
9am-5pm Mon-Fri.
Please have your credit card details ready

OR

Fax (02) 9979 6503
Fax the coupon with your credit card details
24 hours 7 days a week

OR

Mail order form to:
Reply Paid 25
Silicon Chip Publications
PO Box 139, Collaroy 2097
No postage stamp required in Australia

Producing Perfectly Professional Project Panels for Peanuts

One of the questions we're often asked here at SILICON CHIP is "how do you make those great-looking front panels on your projects?"

The answer: We cheat!

By ROSS TESTER

Every project, whether it's one published in a magazine or one you design and build at home, needs a dress panel.

Dymo labels have their place . . . but not on a front panel! However, we've seen these – or worse, hand lettered panels – on many projects over the years, including some submitted to us for publication. It might be a brilliant design but it looks cheap and nasty. If only the designer knew how easy it was to make it look professionally built!

We make our front panels using basic resources which the vast majority of readers would either have, or have access to. And once you know how simple it is to make a professional looking front panel, you'll never again have an excuse to leave that project in an "almost finished" state.

So how do we do it? And more to the point, how can you do it?

Believe it or not, few of the projects you see published in SILICON CHIP now have a metal dress panel (that's the external panel you see, not to be confused with the inner panel which usually is metal or plastic).

Once upon a time, of course, virtually all dress panels were made of metal – usually aluminium. Older readers may remember a product called "Scotchcal", made by 3M and introduced more than twenty years ago.

There were many variations of Scotchcal, the most popular being a photosensitive aluminium sheet with

Here's a close-up of the dress panel of our new Audio Signal Generator featured elsewhere in this issue. Bet you didn't realise that panel is made out of paper, did you?

a self-adhesive backing. A piece of Scotchcal was exposed to UV light through a negative or positive film which contained the image of the panel required.

Slosh-developed using a proprietary developer and cotton balls, a quick, easy and very professional front panel resulted. After drying and coating with a thin spray of clear lacquer, the adhesive backing was removed and the panel was stuck in position on the case, ready to be drilled, cut or shaped as required.

Why are we telling you all this? For two reasons – one, it leads on to the way we are making panels today and two, because many readers would be unaware of the detail it took to present good looking projects.

Sadly, Scotchcal went off the market. There were a few similar products which appeared and disappeared over the years, a recent one being Dynamark. But even that became difficult to obtain – even for a magazine which was able to buy in reasonable quantity. For the reader, wanting just a small sheet for the very occasional panel, it was nigh impossible.

Incidentally, we've heard rumours that one reason products such as these went off the market was the suspicion that some of the developers used contained some quite nasty ingredients – you know, the ones that make laboratory rats and mice grow spare heads and that sort of thing.

Anyway, back to the story: the difficulty in obtaining these products made us start looking for alternatives.

As you might expect, we design our panels on computer "in house" to suit the project under development. We either use a CAD package or more usually, a graphics package. As well as printing, these programs have the option of outputting files in a variety of ways, not the least of which is as a file which another service provider, such as a specialist panel maker, can handle.

For example, in a commercial process, the file might be used for making a silk screen, allowing mass production. Not surprisingly, one-offs using this method are prohibitively expensive. Scratch that idea.

There were other options available to us, particularly through the people who put together kits for our projects. But we were looking for a viable method for our readers.

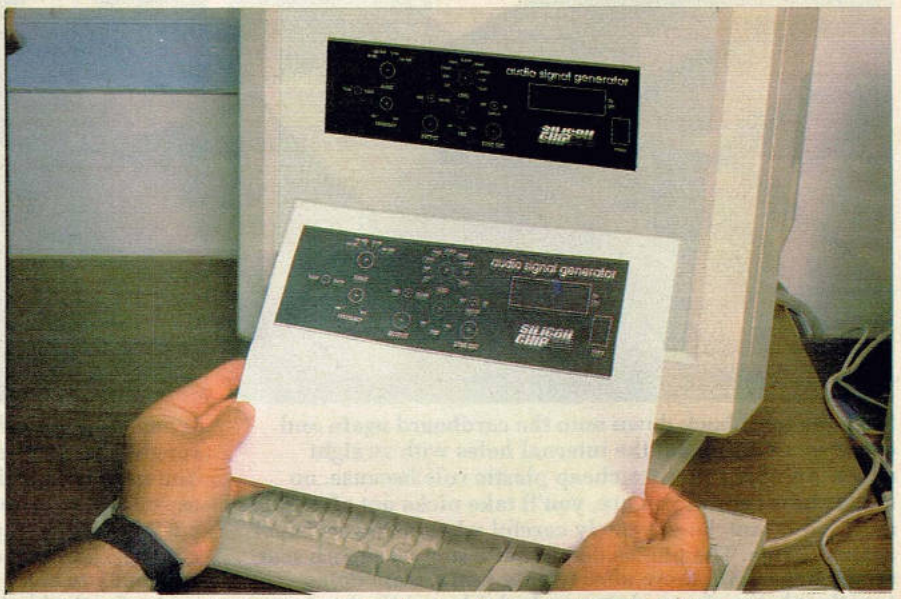
If you're not reproducing a panel from the SILICON CHIP website or photocopying one from the magazine, you'll need to draw up your own. The easiest way is with one of the commercial graphics packages now available. A tip: if making a "reversed" panel (such as shown here, white type on black background), prepare it first the other way around (black on white) and either reverse everything when it's finished or print it as a negative.

For a while we tried photographic images, using the same type of high-contrast photographic paper used extensively in the printing and graphic arts industry.

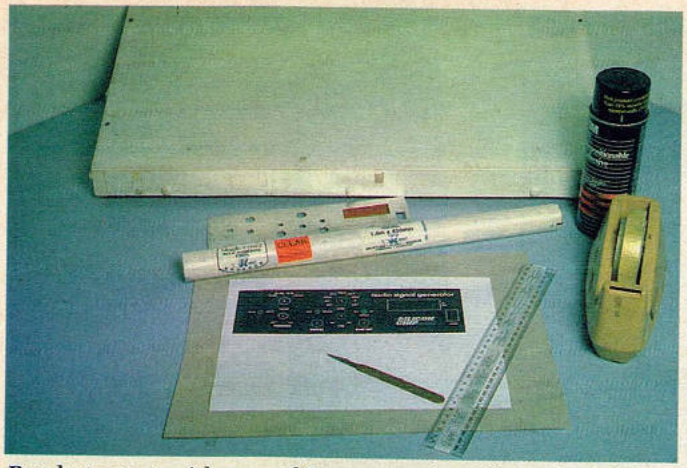
While these worked reasonably well, they had a major disadvantage. Even if the paper was properly "fixed", in time the image started to fade. While good enough for a short term solution, after a time we had to replace the front panel. Scratch that idea as well.

In recent years, a couple of other products have come onto the market. They looked promising at first but (at least the ones we tried) proved too fiddly; too difficult to achieve consistently acceptable results. Scratch them, too.

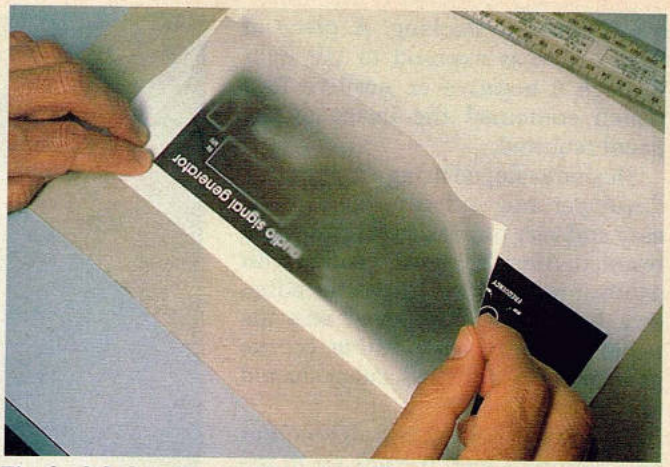
The along came the laser printer. The first models didn't produce a great black but in recent years, laser print-



Here is our paper label, laser-printed directly onto standard 80gsm bond. Compare this to your screen image to make sure nothing has gone awry.



Ready to start with everything we need: we have the label, a roll of clear self-adhesive plastic, a sheet of thick cardboard, a can of spray adhesive, a sticky tape dispenser, a clear plastic rule and a surgeon's scalpel fitted with a new blade. We also had an old newspaper handy for the overspray from the spray glue. The light box is handy but is certainly not essential.



Fix the label to the cardboard using sticky tape on the edges. Cut a piece of contact slightly larger than your label and remove its backing paper. Commence sticking the contact to the label from one corner, using your flat fingernail as a burnisher. Burnish diagonally back and forth, working to the opposite corner of the label removing any air bubbles as you go. Burnish to a consistent finish.

ers have made great progress in this area. In a properly adjusted, modern laser printer, blacks are solid, dense blacks and whites are just that – white.

For a while, we played (for want of a better word) with clear film designed for laser printers. Perhaps this could be used? Try as we might, though, we could never get the blacks on the film to match anything like the rock-solid blacks on plain paper. Scratch that idea.

But this started us thinking (always a bit of a worry, that . . .). If the blacks on paper were so good, could we simply use a laser print of our front panel artwork? Would it need special paper? Would it be accurate enough? How would we protect the surface? How would we stick the panel on?

After some experimentation, we came up with the answers to those questions (which in order are yes, no, yes, read on and read on!) and in the process came up with a dead simple yet highly effective method of making dress panels.

Well, it must be highly effective – because it's managed to fool most people into believing we have discovered a secret source of Scotchcal or Dynamark material!

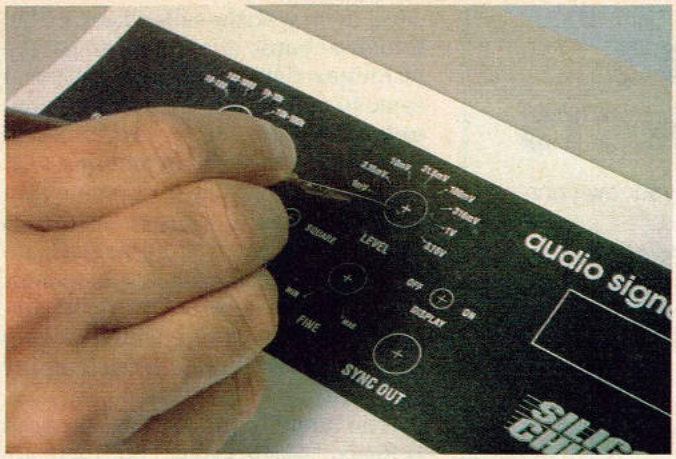
The laser print

Obtaining dense blacks and white whites were only part of the equation. We also needed to ensure that (a) the laser print was dimensionally quite stable (ie, it didn't stretch or shrink markedly in one or both directions) and (b) that the printer didn't leave any heater or wheel marks or other imperfections on the surface (which can happen on solid sections).

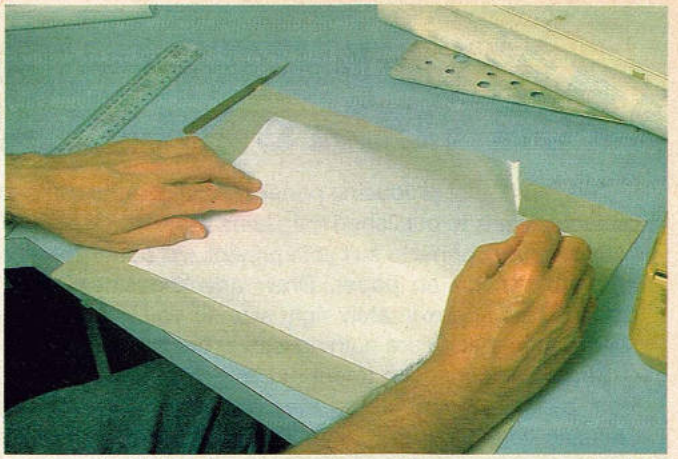
It took a little mucking around with

Stick the label back down onto the cardboard again and commence cutting out the internal holes with straight edges. Another tip: use a cheap plastic rule because, no matter how careful you are, you'll take nicks out of it. And most important, be extremely careful when using a scalpel against a rule. The photos do not quite show a superb scar on my finger, still there after twenty years, from doing exactly what we have photographed. I learnt the hard way (the irony is I was cutting out artwork for a safety sticker!).

When cutting circles, it's much easier to hold the scalpel in roughly the same spot and rotate the work underneath. You need to be quite accurate when cutting small holes, especially ones not covered by knobs or large nuts. Finally, cut the panel away out of the paper. Again, be careful cutting against the rule! You might prefer to use a metal rule but you can't see underneath a metal rule and it's also easier for the blade to run up the metal edge and into your finger.



If you have any air bubbles in the plastic film, they can be removed by piercing them with the very tip of the scalpel blade and burnishing out with your fingernail. It is essential that the blade be very sharp with only the faintest nick in the surface. Imperfections can also be hidden with a black felt-tipped pen.



Unstick the label from the cardboard, turn it over and stick another sheet of plastic film on the opposite side. Use the same techniques (eg working from one corner, etc) but you don't have to be quite so careful with the back because it won't be seen. Any air bubbles, though, should be removed.

the density control on our laser printer but eventually we were able to achieve the results we wanted.

And no, we didn't have to use any special paper – we use the standard 80 gsm five-dollar-a-ream bond paper all of our laser printing is done on.

Not only that, we were able to duplicate the results using a photocopier. As long as your copier is capable of dense blacks with no streakiness or marking (either in the blacks or whites) you can use your copier to make panels.

That means the front panel artwork we almost always publish in SILICON CHIP can be the basis for your panels!

Protecting the surface

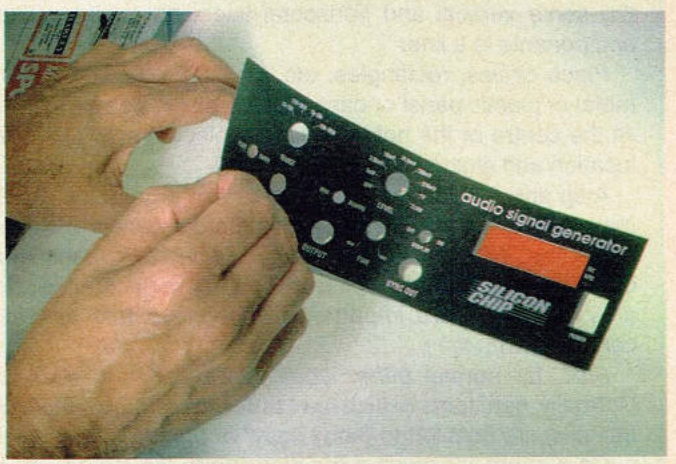
We first tried a number of spray-on products but, without exception, they weren't up to the task. They allowed the panel to be marked or scratched too easily.

The penny dropped one night when I was putting the cutlery away in the kitchen drawer after washing up. (OK, darling, I lied. When I was watching you put the cutlery away . . .). I looked at the self-adhesive plastic covering on the shelves and noticed how little it was damaged – even with continuous use.

Was that plastic covering available in clear (as distinct from the most attractive floral pattern in the cutlery drawer, which might tend to detract from a front panel)? I contacted a couple of suppliers and confirmed that it was indeed available in clear. To be truthful, it's more translucent than clear but that's actually an advantage, as we will see shortly.

We printed a few front panels from artwork we'd done and proceeded to

All cut out – and ready for gluing. Use plenty of newspaper because spray glue does just that – sprays everywhere and glues! There are many types of spray glue available; we used 3M 75 Repositionable Adhesive – it allows you to move the panel after placing in position to get the fit just right. Don't use too much spray glue – a little goes a long way. Most spray glues also require the nozzle to be cleaned after use by spraying the can upside down for a short period.



Speaking of fit, a light box is handy (though not essential – an outside window and daylight also works) to check the line-up of your panel holes to the underlying holes. If necessary, peel the label off and re-stick it. If you find that some holes are just slightly out, try placing the knobs etc in position and check the "fit" – perhaps a little bit of error won't matter.

PRODUCING PANELS FOR YOUR OWN PROJECTS

This method of producing panels is just as applicable to your own one-off projects as it is to published magazine projects.

Design your panel to suit your project, PC board layout and so on, drawing a rough version on paper. Draw any knobs, switches, meters or other components approximately right size so you get a feel for their positioning (and also to make sure nothing is over the top of anything else!)

Some designers like to cut out little circles and shapes representing the front panel components so they can move them around to get the most pleasing "look". It's up to you. You don't have to be a Michaelangelo – the panel simply needs to look good but also be functional.

Sometimes you will design a dress panel to fit an existing case or panel layout. That's another option.

When you are satisfied that everything is where you want it on your rough, carefully measue and mark your drawing with the sizes of component holes (yes, the holes, not the size of its knob or nut, etc), then also dimension it so that everything is fixed in position.

Now's the time to start work on your computer. As mentioned before, we generally use a graphics program such as Corel Draw to prepare our panels. There are lots of similar programs to choose from – just as long as it allows you to accurately place components to a measure.

If you don't have such software, there are loads of shareware graphics programs available on the web. Alternatively we've seen superseded versions of big $$$ commercial software selling very cheaply in all sorts of places – eg, genuine new Corel Draw 5 for $19.95 at Woolies supermarkets just after Christmas (current version 8 sells for $1200+).

Regardless of whether you want your final panel positive (black type on white background) or negative (white type on black background) you will find it much easier to design your panel as a positive image, then reverse it later.

We generally draw the outside of the panel to size, then pull down guide rules (vertical and horizontal) to the positions of our front panel controls. It is usual (for best appearance) that as many controls as possible are located on the same vertical and horizontal lines, so guides make it easy to place components in a line.

Place circles, rectangles, etc, the same size as holes in the underlying metal or plastic panel or case (not the same size as the knob or switch nut!). At the centre of the hole we usually place a cross-hair target to make final location and gluing easy.

A tip about type: one easy way to ruin a good looking panel is to use too many type fonts. Have a look at commercial panels and those published in the magazine. With rare exceptions, you'll find a bare minimum of fonts used – often just one, with perhaps a second (more decorative?) font for the name. If a logo is used, it's important to choose a font that neither clashes nor competes with it.

Also, for normal panel labelling it's better to stick to the basic fonts. Normally, serif fonts (**which have little tails on the tops and bottom of the letters like this**) are best left to "body copy" or printed matter like this magazine.

On a panel, it's much more pleasing to the eye to use one of the "garden variety" sans-serif fonts **(which look like this – notice, no tails?**). Fonts such as Helvetica, Arial, Dutch, Futura or similar are fine.

What if you want a negative image (ie, white type on a black background)?

If you are drawing up your own panel, it would be rare these days to find any drawing or imaging software which would not allow you to print a negative image. If downloading from the website, Acrobat Reader can also print negative *(File- Print- Setup - Properties- Graphics- Print as negative image).*

cover them with the self-adhesive film. It took a couple of attempts to get the technique right, particularly when it came to cutting out the holes for controls, switches, etc. Again, more of that in the step-by-step pictures.

The advantage of a translucent film instead of a fully transparent film is that it looks much more natural. Indeed, our film-covered front panels have the appearance of the matte aluminium panels of old, with a lacquer coating. Clear film looks, well, shiny and fake.

The brand of the material we used is Raeco "Magic Cover" but there are many others available. It's actually sold as clear book covering and is available at most department stores, stationers and even supermarkets. Woollies have 1.5m rolls for less than a dollar (they even have it in translucent colours. Now there's a thought!).

The method of applying the film and the equipment to do it also took some experimentation. After trying a variety of burnishing tools (to evenly apply the film), in the end we came up with a "digital" instrument which is free of charge. It won't take long to find – just look down your arm at those long pointy things. Notice the hard bits on the tips? Yes, your flat fingernails make ideal burnishing tools! (Of course, if you bite your nails you're gonna get scratches).

Cut it out!

Cutting the panel out (actually cutting the various holes) is perhaps the most difficult part of the whole operation. Remember, you need to cut through two layers of plastic and one of paper. The most difficult things to cut out are small circles for mini panel switches and the like. They have small nuts so any slip you make is likely to be visible.

The most essential ingredient is a *v-e-r-y* sharp knife. A typical hobby knife is not really adequate for the task. We use a surgeon's scalpel with a new blade. Just be careful – you know why surgeons use them!

Where a straight cut is involved, don't use scissors. Always use a knife and a guide to make sure you get the cut straight. No matter how good you think you are with a pair of scissors, straight cuts aren't!

Another tip: when choosing front panel components for your projects (eg, panel meters), if possible go for

And here is the finished panel, ready for final assembly. When you are assembling the project, take extra care when placing the panel into a slotted case or when tightening nuts on pots and switches.

Speaking of pots and switches, their knobs and nuts can hide a multitude of sins. As you can see, the hole cutouts are no work of art but are hidden when the knobs and nuts are fitted. If you find a blemish which did not become hidden, a black Pentel pen can often fix it for you!

the one with an escutcheon or surround to hide edges.

Stick it, by gum!

Our first attempts at gluing the panel to the case where slightly less than successful because of the type of glue we were using. Again, we experimented to find the right one.

What we required was a glue which will stick to anything – metal, plastic, paper, you name it – and one which wouldn't shrink as it dried. And there weren't all that many glues which will do that without causing damage to the panel.

I then cast my mind back a year or twenty to a glue commonly used in the graphic arts industry (before computers were invented) – spray adhesive. It's not cheap but what the hell, we bought a can of it and tried it on a paper panel . . . with instant failure.

Our good-looking panels suddenly looked awful!

The problem was that the glue "bled" right through the paper label, turning it into, well, it's hard to explain. But it wasn't the effect I was looking for. How could I stop the glue bleeding into the paper?

The answer turned out to be right under my nose: the self-adhesive plastic sheet. By placing a piece on the *back* of the label as well as the front, a plastic/paper/plastic sandwich if you like, I solved the problem completely. Result: no more bleed-through – and a more durable panel into the bargain!

You don't need much spray glue – just a couple of seconds is more than adequate. Don't overspray or you will get runs of glue which might harden to become visible ridges.

Incidentally, there are several types of spray glue available. We use a "repositionable" glue which means you don't have to be spot on when you first place the label on the case. If you have to move it slightly, you can. (Come to think of it, that was always a major hassle with Scotchcal and Dynamark – you couldn't!).

Softly, softly

When assembling the project, great care must be taken to prevent damage to the panel. Needless to say, even a plastic/paper/plastic sandwich panel is not as tough as a metal one.

The biggest problem is when doing up pot nuts, switch nuts, etc. If you're not careful the nut or washer can "grab" the plastic and twist it, pulling it off the paper. This creates an obvious flaw. Fortunately, pot nuts usually have a knob over them to hide any minor imperfections; with small switch nuts you have to be *very* careful indeed.

Using tools such as spanners or pliers to do up nuts etc also requires care. Ensure the tool does not come into contact with the panel itself.

Finally, be careful if your panel has to fit into slots, as in some of the two-piece plastic cases commonly in use. You need to take your time, making sure that the edges of the panel go all the way down into the slot without creasing or folding.

But still, even if you do botch it, a brand new panel is only a few minutes away, isn't it?

Having said all that, when completed, these panels with their plastic coating are surprisingly robust. The plastic can take quite a deal of punishment and has the advantage of being easily cleaned – a wipe over with a damp sponge and it's as good as new.

Just remember, though, that the edges of your panel are not sealed so if any water gets in you might find yourself making a new panel! (Naturally, the same comments apply around any holes cut in the panel).

Another option?

Since preparing this article a few other thoughts have occured to us. Notwithstanding the comments we made earlier about clear film looking a little fake, if you have access to a laminator it might be worth a try.

Laminating would, of course, be even tougher than our self-adhesive plastic covering so would be even more durable.

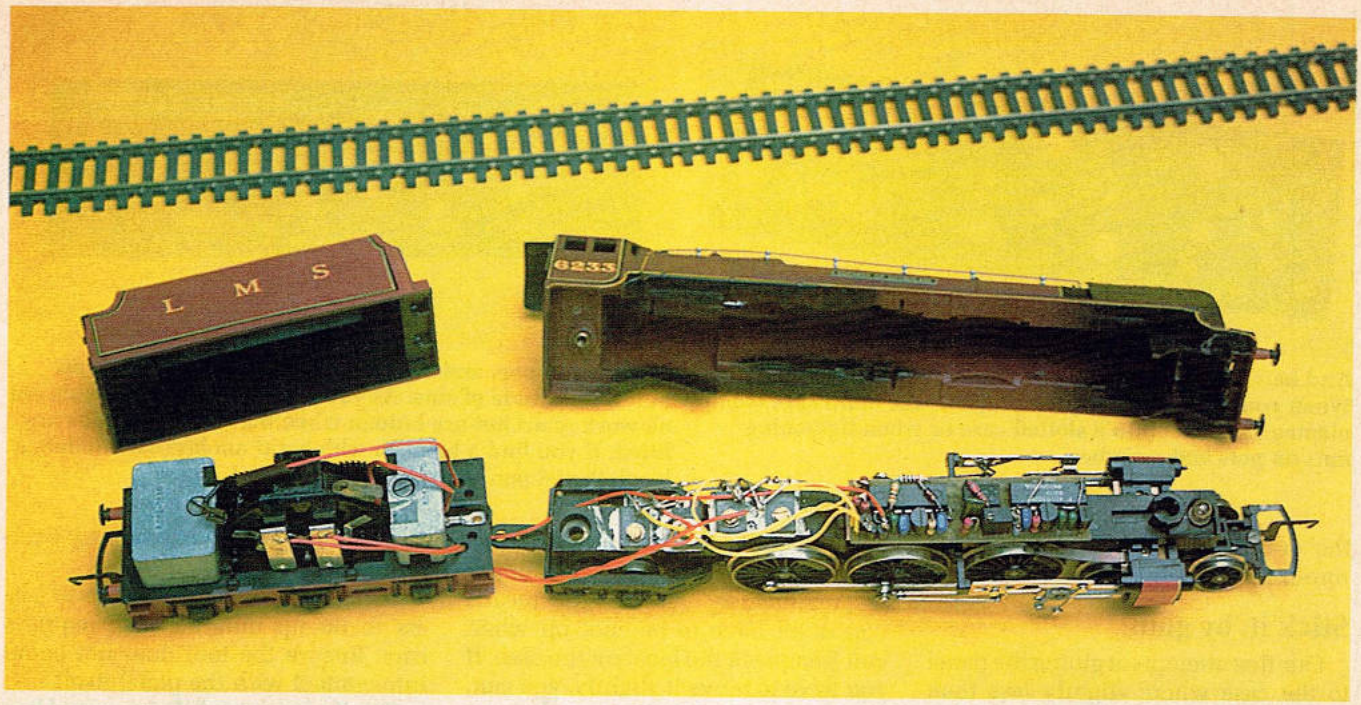
And while we haven't tried it, we cannot see any reason why the spray glue wouldn't be just as effective on a laminated plastic. SC

USING OUR WEBSITE PANELS

As you probably know, front panels recently published in SILICON CHIP are now also published on our website: www.siliconchip.com.au.

These are normally in Adobe Acrobat format, ready for printing (if you don't have a copy of Adobe Acrobat Reader, you can download a copy of it free of charge via our website).

All you need do is print the panel out on a laser printer (or even a quality inkjet printer) for use as described in this article.



Command Control Decoder For Model Railways

This decoder circuit takes a different approach to the design featured in our May 1998 issue. Instead of feeding switched power to the locomotive motor, it feeds smooth DC which is better for some motors, including coreless types. Not only does this circuit use less components but it ends up on a much smaller PC board.

Design by CAM FLETCHER

Our series on Command Control for model railways, which was presented in the January to June 1998 issues of SILICON CHIP, has created quite a deal of interest. While there were some initial problems with the supply of ZN409CE servo decoder chips, these have been overcome for the present and so quite a few systems have been built.

As always though, someone can see a better way or another approach and so it is with this alternative decoder design which feeds smooth DC to the motor and also manages to dispense with the need for the ZN409CE decoder. While achieving this result, the circuit also manages to use less components and is accommodated on a smaller PC board. As a result, it could be fitted into some N-scale locos as well as smaller bodied British OO or HO-scale locos.

Before we describe what this circuit does, we should briefly review the function of the original decoder circuit featured in the May 1998 issue of SILICON CHIP. This was installed inside a typical HO or larger scale locomotive and was fed with track voltage of about 11V DC with a superimposed 5.9V pulse waveform.

The pulse waveform consisted of blocks of 16 pulses separated by a sync "pause" and the width of each pulse contained the speed and direction of each locomotive on the 16-channel system. Ergo, a maximum of

16 locomotives could be simultaneously controlled on the system.

The decoder circuitry extracts the particular pulse from the block of 16 pulses and then that pulse is decoded to drive a H-bridge transistor circuit which drives the locomotive motor. The locomotive can be driven at any speed up to its maximum, in forward or reverse direction. The H-bridge feeds voltage and current to the motor in switching mode at a pulse rate of about 100Hz.

To fully understand the decoder operation and hence the differences between it and the circuit described here, you will need to read the May 1998 article in detail.

The pulsed mode of operation is fine for most locomotive motors and has the big advantage that the driving transistors stay cool and do not require any heatsinks. However some model railway enthusiasts prefer not to run their locomotives with pulsed power. The switchmode operation can lead to noticeable armature and gear-train noise and vibration, especially at low speeds and it can cause heating problems in some coreless motors which are popular with British model railway enthusiasts.

This alternative decoder design uses just three ICs and four TO-126 power transistors for the motor drive. The transistors need to be mounted on the locomotive body, chassis block, ballast weight or other suitable heatsink to dissipate the heat produced because the transistors operate in linear mode rather than switchmode. Ideally, the current drawn by the locomotive will be around 0.1A or less, to minimise this power dissipation. If efficient can motors are used, this small current drain is certainly achievable.

Fig.1 shows the circuit diagram. There are few similarities between it and the circuit of the original decoder published in May 1998 although the principle of operation is broadly the same, as far as recovery of pulses is concerned. From then on, the decoding of the recovered pulse is quite different.

As already noted, the track voltage is a 5.9V train of pulses super-

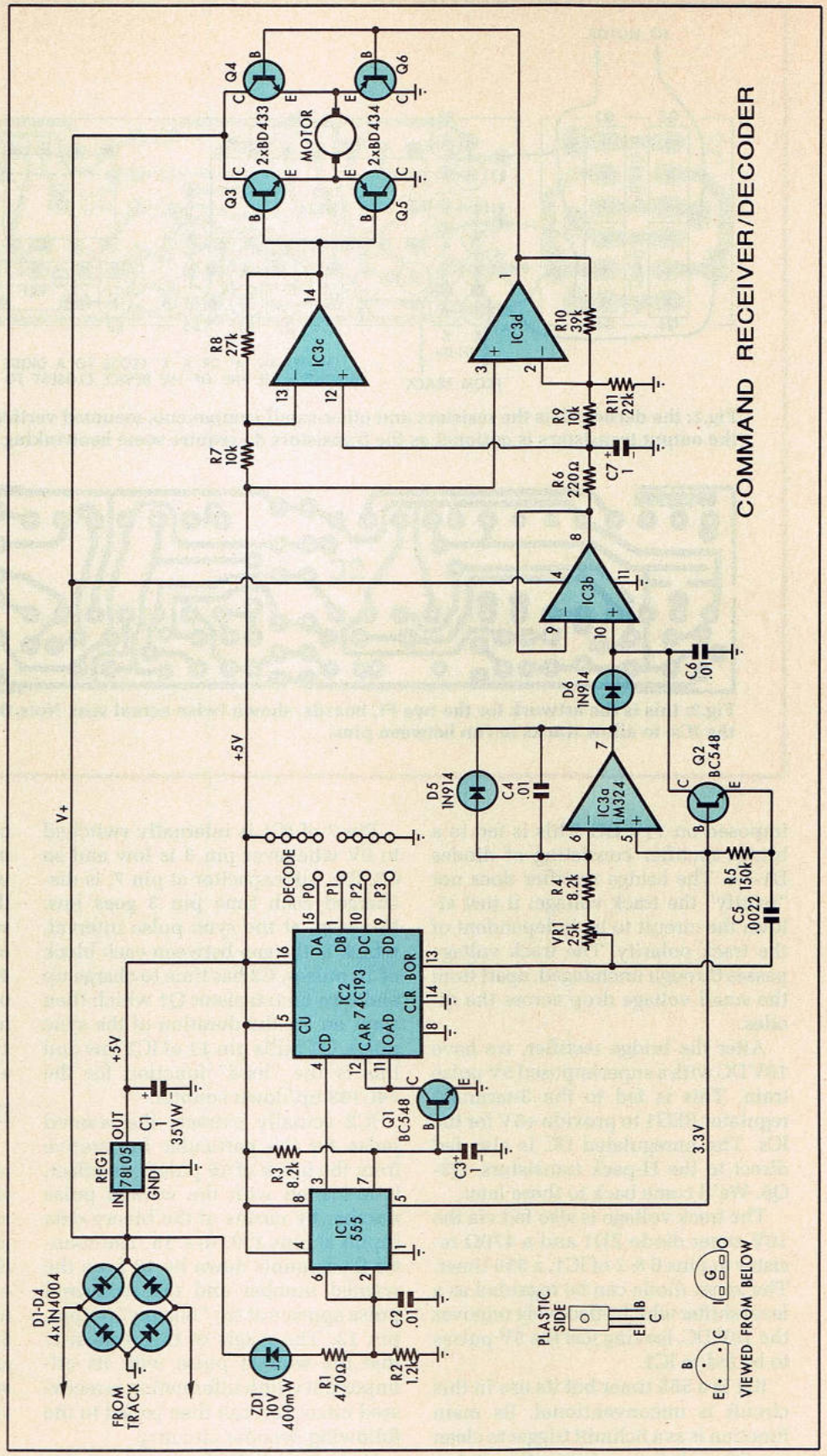


Fig.1: IC1 and IC2 extract the channel pulse from the 16-channel block while IC3a, Q2, D5 & D6 produce a DC output which is proportional to the pulse width. IC3c & IC3d provide the forward/reverse decoding.

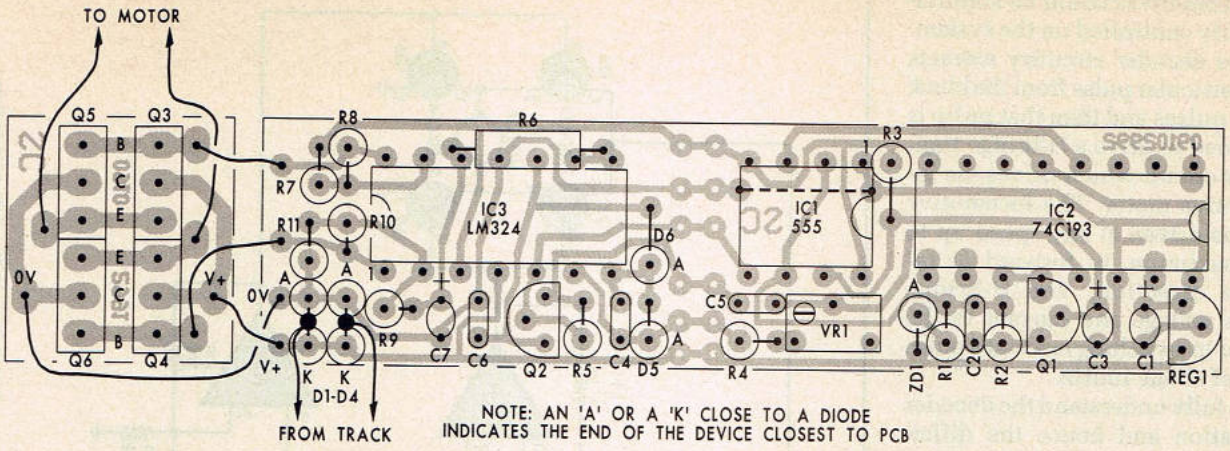


Fig.2: the decoder has the resistors and other small components mounted vertically to save space. The board for the output transistors is optional as the transistors do require some heatsinking. Note the link under IC1.

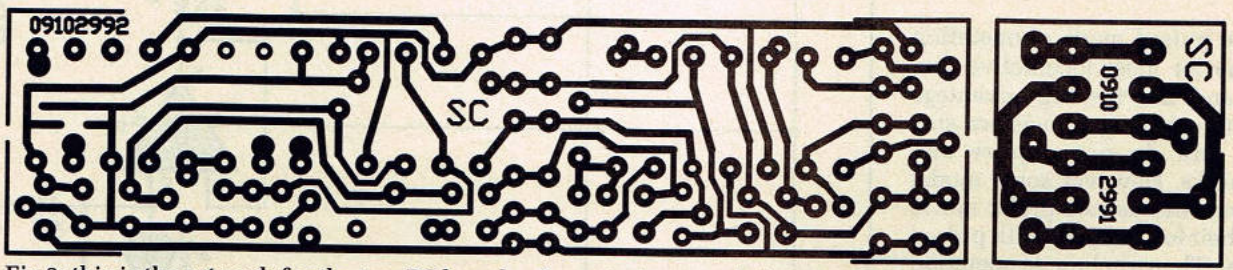


Fig.3: this is the artwork for the two PC boards, shown twice actual size. Note that we have used small pads for the ICs, to allow tracks to run between pins.

imposed on 11V DC. This is fed to a bridge rectifier consisting of diodes D1-D4. The bridge rectifier does not "rectify" the track voltage; it just allows the circuit to be independent of the track polarity. The track voltage passes through unchanged, apart from the small voltage drop across the diodes.

After the bridge rectifier, we have 10V DC with a superimposed 5V pulse train. This is fed to the 3-terminal regulator REG1 to provide +5V for the ICs. The unregulated DC is also fed direct to the H-pack transistors, Q3-Q6. We'll come back to these later.

The track voltage is also fed via the 10V zener diode ZD1 and a 470Ω resistor to pins 6 & 2 of IC1, a 555 timer. The zener diode can be regarded as a level shifter which effectively removes the 10V DC, leaving just the 5V pulses to be fed to IC1.

IC1 is a 555 timer but its use in this circuit is unconventional. Its main function is as a Schmitt trigger to clean up the pulse waveform after it has been fed through the bridge rectifier and zener diode.

Pin 7 of IC1 is internally switched to 0V whenever pin 3 is low and so C3, the 1µF capacitor at pin 7, is discharged each time pin 3 goes low. However, at the sync pulse interval, which is the gap between each block of 16 pulses, C3 has time to charge up and turn on transistor Q1 which then stays on for the duration of the sync pulse. Q1 pulls pin 11 of IC2 low and this is the "load" function for the 74C193 up/down counter.

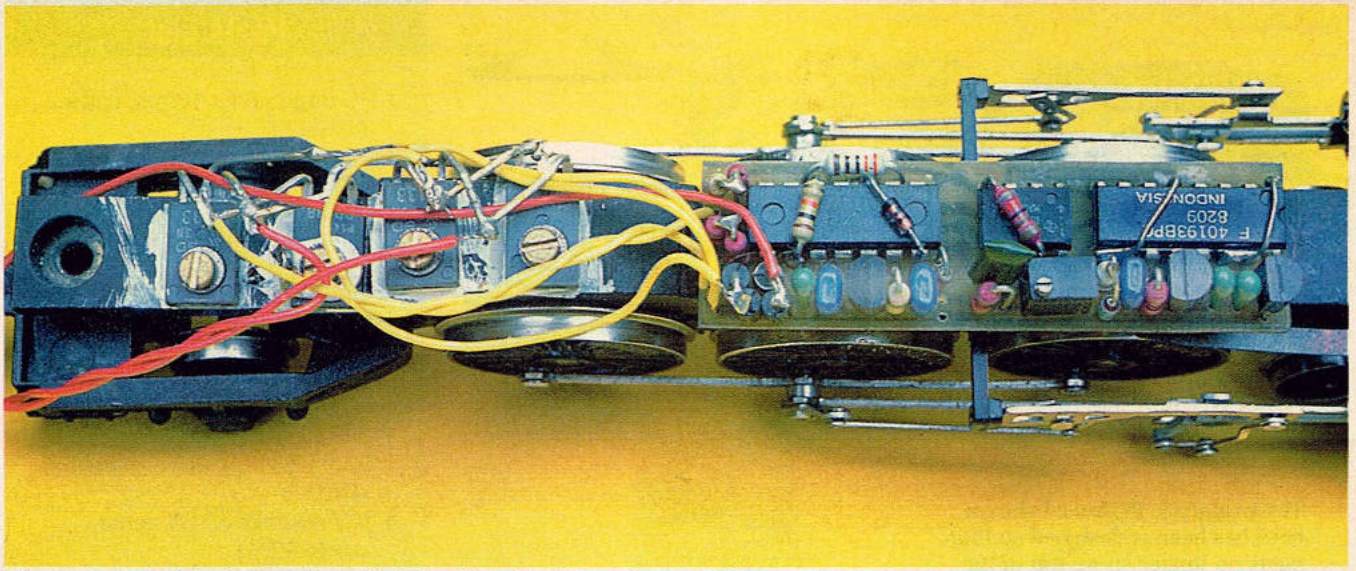
IC2 actually extracts the wanted pulse for the particular locomotive from the block of 16 pulses. In effect, it is loaded with the wanted pulse number by means of the binary data inputs at pins 1, 9, 10 & 15. The counter then counts down by 16 from the wanted number and the recovered pulse appears at the "borrow" output, pin 13. The magic of this system is that the wanted pulse with its all-important width information is recovered intact and can then be fed to the following decoder circuitry.

Going back to Q1 for a moment, it is used to pull pin 11 low for the "load" function. Normally, Q1 would need a collector load resistor of, say, 1kΩ, to make sure that pin 11 is pulled high when Q3 is off; ie, a pullup resistor. In this case though, pin 12 is used to supply the pullup function. This can only be done with the 74C193 or 40193B ICs. If you use other than 74C or B series CMOS for this IC, you will need to isolate pin 12 and provide a 1kΩ pullup resistor from pin 11 to the +5V rail.

Decoder operation

As already noted, this circuit dispenses with the ZN409CE decoder chip. Instead, the decoding operation is performed by IC3a & IC3b in conjunction with Q2, D5 & D6. Pin 5 of IC3a and the base of Q2 are biased at +3.3V from pin 5 of IC1. This is not a normal use for the threshold pin of a 555 but it works in this application and saves resistors which would otherwise be required for a voltage divider.

The recovered pulse output from pin 13 of IC2 is applied via capacitor C5 to the emitter of Q2 and to the inverting input, pin 6, of IC3a via



The prototype decoder was installed in a Hornby OO scale steam locomotive and is small enough to fit into some N-scale locomotives. Since the output transistors are driven in linear mode they need to be mounted on the locomotive chassis for heatsinking.

trimpot VR1 and resistor R4. Normally, the output of IC2 at pin 13 sits at close to +5V and since pin 5 of IC3 is at +3.3V, the output at pin 7 will be low (ie, close to 0V). Diode D5 conducts and so pin 6 is also held at +3.3V.

When the recovered pulse is delivered from pin 13 of IC2, pin 6 of IC3 is pulled low (ie, it is a "low-going" pulse) via VR1 and R4 and so pin 7 goes high. D5 is now reverse-biased and capacitor C4 charges, pulling pin 6 lower. At the end of the input pulse, pin 7 goes low again and C4 is discharged via D5. In effect, IC3a acts as an integrator of the recovered pulse and produces a DC voltage which is proportional to the width of the recovered pulse.

Diode D6 and capacitor C6 act as a peak detector or "sample and hold" circuit. C6 is charged to the peak of the integrator's output and again, the DC voltage across it is proportional to the width of the input pulse. C6 needs to be partially discharged each time a new input pulse appears because the new pulse may be narrower, corresponding to a new speed and direction setting. This partial discharge is achieved with Q2 because its emitter is fed with the input pulse from IC2. Q2 acts like a grounded base stage, turning on briefly when its emitter is pulled low via C5, which enables it to discharge C6.

Op amp IC3b acts as a unity gain buffer for the sample-and-hold circuit which drives the output amplifiers, IC3c and IC3d. However, even this part of the circuit is not as simple as it appears. IC3c is connected as a non-inverting amplifier and is biased to +5V from the 3-terminal regulator. By contrast, IC3d is wired as an inverting amplifier and its pin 3 is also biased to +5V. Both IC3c & IC3d have a gain of about 3.8.

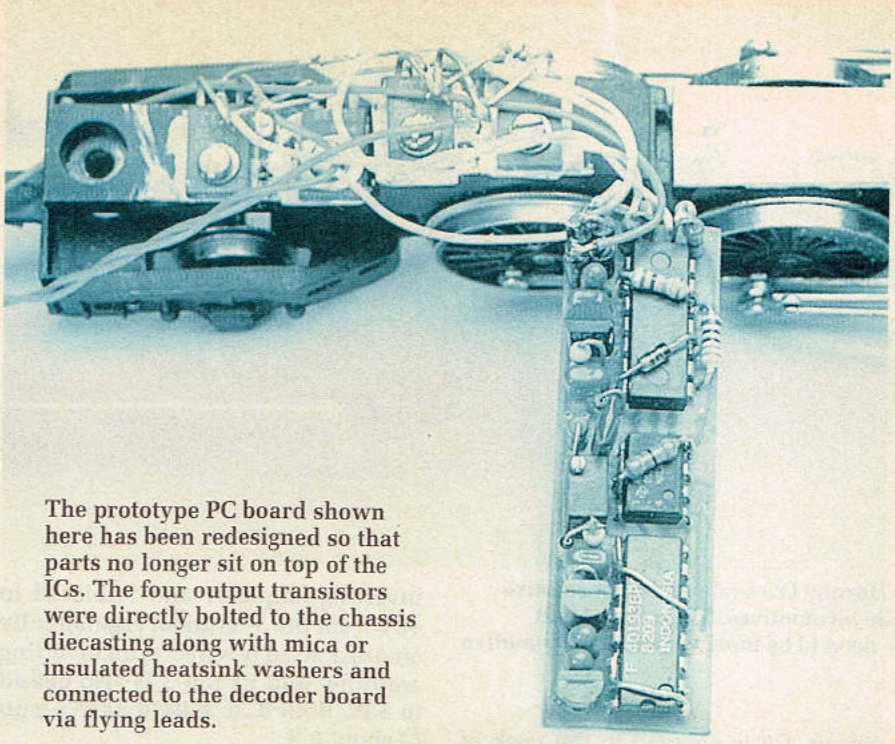
Linear drive

Now when the output of IC3b is around +6.5V no power is delivered to the motor because the voltage difference between pins 1 and 14 is insufficient to bias on the respective output transistors. Q3-Q6 look like an H-bridge configuration as used in the original decoder featured in May 1998 but the circuit function is more akin to a push-pull complementary emitter follower setup. When the output of IC3c goes up, IC3d goes down and motor current flows via Q3 & Q6 while Q4 & Q5 are held off.

Similarly, when IC3c's output goes down, IC3d's output goes up and motor current flows in the opposite direction through Q4 & Q5 while Q3 &

Resistor Colour Codes

❑	No.	Value	4-Band Code (1%)	5-Band Code (1%)
❑	1	150kΩ	brown green yellow brown	brown green black orange brown
❑	1	39kΩ	orange white orange brown	orange white black red brown
❑	1	27kΩ	red violet orange brown	red violet black red brown
❑	1	22kΩ	red red orange brown	red red black red brown
❑	2	10kΩ	brown black orange brown	brown black black red brown
❑	2	8.2kΩ	grey red red brown	grey red black brown brown
❑	1	1kΩ	brown black red brown	brown black black brown brown
❑	1	470Ω	yellow violet brown brown	yellow violet black black brown
❑	1	220Ω	red red brown brown	red red black black brown



The prototype PC board shown here has been redesigned so that parts no longer sit on top of the ICs. The four output transistors were directly bolted to the chassis diecasting along with mica or insulated heatsink washers and connected to the decoder board via flying leads.

Q6 are held off.

Note that while two transistors are always off, the other pair are driven in linear mode instead of switch mode so they will get hot, depending on the amount of motor current.

The other point to consider is that the motor does not get pure DC but a portion of the track voltage. For example, at full speed, the motor will get about 9V DC plus the superimposed pulse waveform although its amplitude is reduced in proportion. In practice, this does not effect the motor operation at all and it behaves as though it is fed with pure DC.

Decoder PC board

The photos in this article show the prototype decoder built into a Hornby OO scale steam locomotive. This is a tender-drive loco (ie, the motor is in the coal tender) and so the decoder has to fit in the limited space inside the boiler. As built, the main decoder board is mounted on the chassis while the four output transistors dispense with a PC board. Instead, they are bolted directly to the chassis diecasting along with mica or insulated heatsink washers and with flying wires back to the decoder board.

We have redesigned the prototype board so the layout shown in Fig.2 is somewhat different to that shown in the photos. The main decoder board measures 64 x 16mm (code 09102992) while the optional output transistor board measures 15 x 16mm (code 09102991). In addition, the decoder board may be cut in two and installed in different parts of the locomotive, with wires linking the two, if that is necessary to fit it in.

Because both boards are so small, you will need to take great care when assembling them; the risk of solder shorts between tracks is high. You will need to use a temperature-controlled soldering iron with a small tip and be very carefull when soldering to the small IC pads. We have used small pads for the ICs to allow tracks between pins and for close component spacing.

Ideally, you should also use an illuminated magnifier for this close and detailed work otherwise you are asking for trouble. Follow the diagram of Fig.2 exactly, particularly with regard to the orientation of the resistors and other vertically mounted components.

The bridge rectifier is tricky since the diodes are mounted vertically to save space. Note that their pigtails should be kept as short as possible as well. The anodes of one pair of diodes connect to the 0V rail while the cathodes of the other pair connect to the V+ rail. The two wires from the track (actually from the locomotive wheel collectors) to the bridge rectifier are made as aerial connections to the paired diodes, in agreement with the circuit of Fig.1.

The capacitors need to be as small as possible and that means tantalum for the 1µF units, monolithic for the .01µF units and greencap for the .0022. Other types will not fit.

When the boards are complete you will need to temporarily connect a motor and power up the power station. The encoder and decoder must be set to the same channel. The full procedure for setup and programming is the same as described in the May 1998 issue of SILICON CHIP. **SC**

Parts List

1 PC board, 64 x 16mm, code 09102992
1 PC board 15 x 16mm, code 09102991
1 25kΩ top adjust miniature sealed trimpot (VR1)

Semiconductors
1 555 timer (IC1)
1 74C193, 40193B programmable up/down counter (IC2)
1 LM324 quad op amp (IC3)
1 78L05 3-terminal 5V regulator (REG1)
1 10V 400mW or 1W zener diode (ZD1)
2 BC548 NPN transistors (Q1,Q2)
2 BD433 NPN transistors (Q3,Q4)
2 BD434 PNP transistors (Q5,Q6)
4 1N4004 silicon diodes (D1-D4)
2 1N914, 1N4148 signal diodes (D5,D6)

Capacitors
3 1µF 35VW tantalum electrolytics
3 .01µF monolithics
1 .0022µF greencap (metallised polyester)

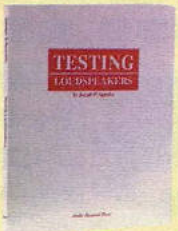
Resistors (0.25W, 1%)

1 150kΩ	2 8.2kΩ
1 39kΩ	1 1.2kΩ
1 27kΩ	1 470Ω
1 22kΩ	1 220Ω
2 10kΩ	

Jaycar ELECTRONICS February SALE

Prices valid until End February '99

Testing Loudspeakers by Joseph D'Appolito



Testing Loudspeakers - is divided into two broad areas that might humorously be labled BC and AD. That is, Before Computers and After Digital. Chapters 2 - 5 cover classic analog techniques for measuring impedance. Thiele/Small parameters, low-frequency enclosure alignments, and frequency response using relative simple and widely available analog test equipment. Chapter 6 and 7 cover the use of PC-based electrical and acoustic data aquisition & analysis system in loudspeaker testing. Chapter headings include:- • 2-Driver testing • 3-Low frequency system electrical impedance tests • 4-Acoustical testing of single drivers • 5-Acoustical testing of multiple - driver systems • 6- Time, frequency and the Fourier Transform • 7-Loudspeaker testing with PC based acoustic data acquisition systems. This book was reviewed in Speaker Building Magazine No.6, 1998. These are exerpts from the review: "The book fills a real void in technical literature and is packed with useful information. Chapter 2 alone is worth the price of the book. If you are seriously interested in loudspeaker testing. Order a copy." Softcover 280 x 215mm. 174 pages.

NEW MEM

Cat. BA-1420 **only $69.95**

DON'T FORGET TO VISIT OUR WEB SITE: www.jaycar.com.au

Jaytech 8 Sector Alarm Deal

Save a fortune by buying our ALARM DEAL using the Jaytech 6000 panel. Includes all the components needed to give you a quality basic home alarm system. All you need is a bit of labour & you have a reliable affordable alarm that offers you peace of mind.

INCLUDES	NORMAL PRICE
1 x 8 sector Jaytech panel	$129.50
2 x Micron pulse count PIRs	$53.90
1 x mains power supply	$23.50
2 x reed/magnet switches	$9.00
1 x siren horn	$23.95
2 x deterrent stickers	$4.00
60 m of 4 core alarm cable	$51.00
NORMALLY PAY	$294.85

Cat. LA-5450 **Was $229 February $199**

32V 150W Halogen Swimming Pool Light

Are you sick and tired of paying well over $30 for a replacement globe for your swimming pool light? We certainly were! So we've done something about it. Attention Pool Shops and bulk users - Contact our Wholesale Dept. for fantastic prices for quantity buys. Cat. SL-2725 **$24.95**

NEW MEM

JC50 10" Speaker Kit

NEW MEM

See EA December for details. Speaker kit & built cabinets.

AURA SHAKER MOTOR ASSEMBLY Cat. XC-1008

An experimenters delight. These units are very similar to those fitted in some really up-market movie theatres.Specifications for the Subsonic Actuator: •Operating Frequency: Subsonic, Max force: 20 foot pounds, Nominal Force: 0.5 foot pounds per watt •Rated power: 18 watts continuous RMS. •250(W) x 300(H)mm •Weight:1.5kgs

$24.95

CCD Camera in Case with Infra Red Illumination

Brand new unit replaces old model which sold for $169.50. This unit is much smaller, measures only 65W x50Hx40Dmm and is black in colour. 6 LEDs give the IR illumination which means it can "see in the dark" to some extent. Includes RCA socket for video and 2.1mm DC socket for 12V DC. Great price! Cat. QC-3466

NEW MEM

Only $139

AURA INTERACTOR BODY BLASTERS CUSHION

FEEL THE ACTION

$200 $79.95

LESS THAN 1/2 PRICE

FEB $49.95

We have made a huge distress stock purchase from AURA in USA. We have sold thousands of the Interactor Backpacks, and now can offer a CUSHION VERSION, for a crazy low price. The cushion should sell for well over $200, but you can grab one - or more, for only $49.95 each, while stock lasts. THEY ARE WELL UNDER 1/2 PRICE! This Interactor Cushion will transform low sounds into movement, so you can actually feel these through your back. Simply place in your lounge chair, or seat, and complete a 3D sound environment for added impact for home theatre, computer games etc. The Interactor Cushion can be used with almost any PC/Mac, home theatre system, CD player or video. Supplied with black cushion (with inbuilt shaker), amplifier module, 240V mains power supply and connecting lead set.

Cat. XC-1005

was $49.95

FEB $39.95

Cat. XC-1000

BACKPACK

Plug it into computer games, stereos etc, then put the back pack on and feel all the low frequency sounds. See 98 Cat. page 213 for full details.

AURA ADAPTOR CABLE FOR N64 & PLAYSTATION

This pack contains all the leads required to attach the Aura Interactor Backpack to your games console and stereo system. Includes RCA piggyback lead, 3.5mm phone to 2 x RCA adaptor lead, RCA joiners & stereo Hi Fi RCA cable. Total value $17.40. Cat. XC-1001 **$11.95**

New Computer Memory Backup Batteries

NEW MEM

AA LITHIUM EXTERNAL BATTERY

This battery (unlike cheaper imitations) uses one AA lithium cell, is encapsulated and designed for external mounting. Its supplied with a lead and Berg flat plug. Voltage is 3.6V, 2.1AH. Supplied with velcro mounting strip. Tadiran brand, size 61(L)x17(H)x16(W)mm.

Cat. SB-2412 **$29.95**

VARTA 3.6V NI-MH

Similar to our lithium battery, but this one is suited if a recharging current is fed to it by the computer. Current is 70mAH. Has 2 PC pins for PC board soldering. Size Pin spacing 19mm. 19(L) x 17(dia)mm.

Cat. SB-2428 **$12.95**

Don't forget our Lithium 3.6V battery.

Cat. SB-2540 **$11.95**

OVERNIGHT DELIVERY

OVERNIGHT DELIVERY

VULKAN Professional

Buy in February for $89 and receive the following for free

$39.80 VALUE FREE

Cat. TS-1200

2 x HOT BLOW TIPS (TS-1217) Value $19.90
2 x FLAME TIPS (TS-1219) Value $19.90
$39.80

12V ACTIVE COLOUR ANTENNA UHF / VHF / FM

IDEAL FOR CARAVANS, CARS, CAMPING AND HOUSES WITHOUT 240VAC MAINS! The antenna contains a built-in amplifier that operates from 12VDC. It can be powered from the vehicle's battery and/or use it at home with the optional AC mains adaptor. (MP-3002 $12.95). The antenna has telescopic dipoles at the rear for fine-tuning your reception, while the amplifier has a built-in splitter for a second TV antenna, a 6 metre coaxial lead with plugs, and a 12V power lead. Specifications: •Gain 22-24dB •Power source: 12VDC, 100mA •Antenna size: 340(W) x 375(L) x 55(D)mm.

Cat. LT-3170 **ONLY $59.95** NEW ITEM

4 Zone Home Alarm Sellout

Includes •Control Panel •PIR •3 Reed magnets •Inside screamer •Power supply.
See 98 Cat. page 76 for full details. Cat. LA-5410
Was $129.50 Feb $89.50 Save $40

6, 9, 12V DC 1 Amp Regulated Power Supply

Cat. MP-3032
Crazy Price! Was $39.95
Save $14.95 Feb $25!!!

9 VAC1 Amp Power Supply

With 2.5mm DC plug.
Cat. MP-3024 **Only $10ea.**
Buy 10 $8ea

Hard Drive Bible

430 pages - Hardbound. See 98 Cat. page 215 for more details.
Cat. BC-1210 **Was $49.95**
Save $29.95 Feb $20

2 Door Power Window Kit

See 98 Cat. page 72 for full details. Cat. LR-8840
Was $249 Feb. $169 Save $80!

CCD B&W Camera with Infra Red Leds

PC board camera with 6 x IR LEDs for illumination. See 98 Cat. page 200 for full details. Cat. QC-3465
Was $135 LIMITED QUANTITY
Feb. $115 Save $20

150 Watt Switchmode Power Supply

Output voltage are •3 x +5 volts @ 10 amps total •1 x +12 volts @ 2.5 amps total •1 x -12 volts @ 1.5 amps total •1 x +24 volts @ 160mA total LIMITED QUANTITY
Cat. MP-3045
Was $29.95 Feb. $15 Save $14.95

Digital Tyre Pressure Gauge Sellout

Measures in PSI. For specs. see our 1998 Cat. page 212. Cat. QM-7235
Was $21.95 Save $5 Feb $16.95

WHAT A FLOP!!

Talking Calculators

Grab a talking calculator for about the same price as a normal one!
Not available at Dealers.
8 DIGIT Cat. QM-7275
Was $24.95 Sellout $5
10 DIGIT Cat. QM-7276
Was $29.95 Sellout $7

Phone Wall Bracket

Phone socket is RJ12 6P4C, and has a 30mm lead for phone connection. Standard wall plate fitting size. Colour is beige.
Cat. YT-6062 **$6.95**

DIGITAL ORGANISERS

See Cat. P206 for details.
32K Memory
Cat. QM-7340
Was $49.95
Feb $20.00
64K Memory
Cat. QM-7345
Was $65
Feb $30.00
LIMITED QUANTITIES

COLOUR CCD CAMERA

1/4" Digital, in a small black metal case. Supplied with a BNC socket and DC power socket. Plug into video input socket on VCR or TV. Small size!!

Specs: •Pick up elements: 1/4" CCD •Pixel: 512(H) x 582(V) •Broard Lens: f3.6mm/f2.0 .70°Angle •Power Source: 12VDC +/-10% •Size:36 x 36 x 15mm. Cat. QC-3482
Only $249.50

SCREECHER CAR ALARM MKII

With high deterrent capacity for a minimum outlay, the Screecher MKII is more effective than the extremely popular MKI from 1986. Using an 'ear-piercing' piezo siren, this alarm will scare the pants off any would be thief. This simple to construct project features entry delay with soft warning tone, exit delay & high intensity deterrent LED. Kit includes PCB, siren, all electronic components and two warning stickers.
Cat. KA-1813
$29.95

Phone Wall Bracket with Side Entry Sockets

As above, but with an additional socket on each side, ideal for answer machine, caller ID or phone.
Cat. YT-6063 **$7.95**

EMAIL ORDERS mailorders@jaycar.com.au

RJ45 Surface Mount Socket

Side entry surface and socket. Has RJ45 8P8C socket. Connect via screw terminals. Size 50(W) x 57(H) x 20(D)mm. Beige colour.
Cat. YT-6084 **$4.95**

ELECTRONIC CLEANING SOLVENT COMPUTER CLEAN

This is EXACTLY the same as our standard Electronic Clean Solvent (Cat. NA-1004 $9.75) which is ideal for use on delicate electronic, electrical and precision mechanical assemblies (ie tuners, switches, plugs, sockets, relays, pots etc.). A highly efficient fast drying solvent of high purity. Cat. NA-1005
Normally $9.75 BELOW HALF PRICE
This Lot Only $3.99ea

BUY 10 LESS 10%

MAIL ORDER - FREECALL FOR PHONE ORDERS 1800 022 888

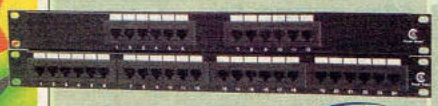
CAT 5 ACCESSORIES

Patch Leads

RJ45 to RJ45. Standard Cable.

Colour	Length	Cat	Price
Blue	0.5 m	YN-8100	$5.95
Blue	1 m	YN-8101	$7.50
Blue	2 m	YN-8102	$9.95
Blue	3 m	YN-8103	$11.95
Blue	5 m	YN-8104	$14.95
Red	0.5m	YN-8110	$5.95
Red	1m	YN-8111	$7.50
Red	2 m	YN-8112	$9.95
Red	3 m	YN-8113	$11.95
Red	5 m	YN-8114	$14.95
Yellow	0.5 m	YN-8120	$5.95
Yellow	1 m	YN-8121	$7.50
Yellow	2 m	YN-8122	$9.95
Yellow	3 m	YN-8123	$11.95
Yellow	5 m	YN-8124	$14.95
Green	0.5 m	YN-8130	$5.95
Green	1 m	YN-8131	$7.50
Green	2 m	YN-8132	$9.95
Green	3 m	YN-8133	$11.95
Green	5 m	YN-8134	$14.95
Grey	0.5 m	YN-8140	$5.95
Grey	1 m	YN-8141	$7.50
Grey	2 m	YN-8142	$9.95
Grey	3 m	YN-8143	$11.95
Grey	5 m	YN-8144	$14.95

Cat 5 Patch Panels



Has 110D terminal blocks, can be used for both Krone and 110 impact tools, and has combined T568A and T568B colour coding. Black in colour, top entry type and 19" rack mounting. Cat 5 certified. Size 478(L) x 43(H) x 32(D)mm.

12 PORT Cat. YN-8040 **$169**

24 PORT Cat. YN-8042 **$225**

Keystone Flush Plates

Fit standard Australian wall fittings. White in colour.

SINGLE PORT Cat. YN-8010 **$2.95**

DOUBLE PORT Cat. YN-8012 **$2.95**

TRIPLE PORT Cat. YN-8014 **$2.95**

110 Keystone Jacks

Suits plates and boxes. White in colour. Cat. YN-8030 **$8.95**

Keystone Surface Boxes

Side entry to accept standard Keystone 110 jacks. Colour white.

SINGLE PORT Cat. YN-8022 **$3.95**

DOUBLE PORT Cat. YN-8024 **$4.50**

CAT 5 UTP SPLITTER

RJ45 plug to 2 x RJ45 sockets. Accommodates 2 services over the one cable. Typically a single 4 wire telephone & a standard Ethenet computer, or 2 PC's can be used over 1 cable. Standard wiring. Length 150mm.

Cat. YT-6090 **Only $16.95**

6 Way Power Outlet with Mains Filter

Not only is it a 6 way power board, it incorporates: •Voltage surge protection •Spike protection •Noise rejection filter network •Safety curcuit breaker. Ideal for running your computer gear, telephone, fax, answering machine, HiFi, video & TV equipment. Cat. MS-4030

Was $42.95

Save $6 **Feb $36.95**

AA MICROTAC REFILLABLE CASE

Ideal spare to have with Alkaline batteries in case you get stuck. Cat. HC-6950 **Was $13.95**

Feb $8.95 Save $5

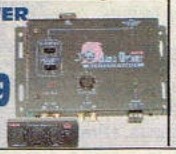
Car Sound Bargains

AMP 100Wx2 Cat. AA-0432 **$249**

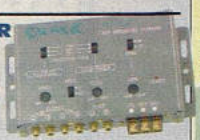
AMP 50Wx4 Cat. AA-0438 **$339**

15 BAND EQ X/OVER Cat. AA-0422 **Was $339** **Feb $239** **Save $100**

BASS DRIVER Cat. AA-0426 **Was $159** **Feb $99** **Save $60**



2 WAY X/OVER Cat. AA-0450 **Was $99.95** **Feb $69.95** **Save $30**



Multi Electronic Tester!!!

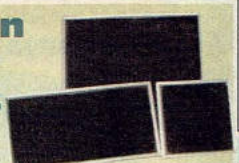
Checks AC and DC volts, continuity, transistors & diodes plus more! See Cat. P29 for details. Cat QP-2260

Was $17.95

Feb $12

Save $5.95

Save on Solar Panels



See 98 Cat. page 85.

1 WATT 6 VOLT

Was $24.95 Save $4.95

Feb. $20 Cat. ZM-9020

2 WATT 12 VOLT

Was $45.95 Save $5.95

Feb. $40 Cat. ZM-9024

4 WATT 12 VOLT

Was $79.95 Save $10

Feb. $69.95 Cat. ZM-9026

Pen Type Digital Multimeter

•Logic •Buzzer •Auto/manual •Data hold •Diode. See 98 Cat. page 20 for full details. Cat. QM-1420

Was $54.95 *Limited Qty

Feb. $45

www.jaycar.com.au

"AA" Size Rechargeable Batteries

TYPE	CAT #	PRICE
600MA NICAD	SB-2452	$2.50
1AMP NICAD	SB-2440	$3.75
1AMP NI-Mh	SB-2455	$4.25
1.3AMP NI-Mh	SB-2438	$5.25

OTHER SIZES

AAA 280MA NICAD SB-2453	$6.50Pr
AAA 550MA NI-Mh SB-2430	$4.50Ea
C 2.25MA NICAD SB-2464	$7.95Ea
C 3.3A NI-Mh SB-2433	$12.95Ea
SUB C 1.3A NICAD SB-2456	$5.50Ea
SUB C 1.8A NICAD SB-2468	$7.50Ea
SUB C 2.5A NI-Mh SB-2432	$9.95Ea
D 1.8A NICAD SB-2461	$7.50Ea
D 5.1A NICAD SB-2466	$16.95Ea
D 7.4A NI-Mh SB-2434	$27.95Ea

FAST NICAD CHARGER WITH DISCHARGER

The "It does everything charger". Charges AA, AAA, C and D Nicads in 4 hours. See 98 Cat. page 86 for full details. Cat. MB-3500

Normally $69.95

Only $49.95

Save $20!!

PIN VICE

Handy addition to any tool case. All metal construction with two internal collars. The head rotates freely making it ideal for drilling delicate PCBs or plastic cases Cat. TH-1772

$9.95

Desk Mount Magnifying Glass

Mains operated, 22W circular fluro tube. See 98 Cat. P185 for details.

Cat. QM-3525 **WAS $149.50**

Save $24.50 Now $125

MEMOREX DIGITAL STEREO EARPHONES Limited quantity

Top quality. Cat. AA-2032

Were $39.95

Then $19.95

Feb Sellout $12

OFC Pro Series Lead

2 RCA to 2 RCA. Length 5 metres.

Cat. WA-1076 **Was $19.95**

Feb $13 Save $6.95

Low Cost DMM

•3.5 Digit •Transistor •Diode •10 Amp •Plug in leads. See 98 Cat. P20 for details. Cat. QM-1500

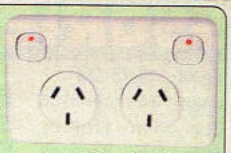
Normally $19.95

Feb. $15

Save $5

OVERNIGHT DELIVERY

AUSTRALEC SWITCHGEAR



We now stock a range of 240V household power points made by *Australec*. These products are very keenly priced. Bulk users contact our Wholesale Department for amazing new prices.

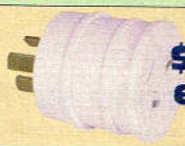
PRODUCT	CAT #	$	PRODUCT	CAT #	$
Single Power Point	PS-4040	9.95	30mm Mounting Bracket - Plastic	PS-4062	3.95
Modular Single Power Point	PS-4042	10.95	16mm Mounting Bracket - Plastic	PS-4063	3.75
Single Architrave Switch	PS-4050	5.50	Large Junction Box	PS-4065	4.75
Double Architrave Switch	PS-4052	8.50	Small Junction Box	PS-4066	4.95
Single Wall Light Switch	PS-4055	5.95	Globe Batten Holder	PS-4070	5.50
Double Wall Light Switch	PS-4057	8.95	Behind GPO Mount Bracket	PS-4077	1.20
Protect-A-Point Double			Behind Plaster Bracket	PS-4078	2.50
Safety Power Point	PS-4058	19.95	Mains Panel Socket	PS-4090	4.95
Double Power Point	PS-4060	11.95	Mains Surface Socket	PS-4092	5.50
Extra Switch Kit for Double Pwr Point	PS-4061	5.95			

Upside Down Adaptor

Changes the earth pin from the bottom to the top!

Cat. PP-4028 **$4.95**

90° Adaptor



Ideal if a plugpack adaptor covers a switch.

90° to RIGHT Cat. PP-4029

90° to LEFT Cat. PP-4030

$5.95 each

Passive Infra Red & Microwave In 1

The ultimate in PIRs for home/warehouse burglar alarms. Requires both the PIR and microwave to be triggered at the same time, virtually eliminating false alarms. **Were selling for $99.50 in 1996!**

10m range for home Cat. LA-5012

Buy 1 for $55 each

Buy 4 for $50 each

15m for hallway or warehouse Cat. LA-5013

Buy 1 for $60 each

Buy 4 for $55 each

2.0uf 250VDC Cap

Our normal price for these is $2.25 each. We've made a bulk surplus deal, and can offer these at well below normal price. They are white in colour, size 31(L) x 10.5(W) x 20(H)mm. Lead spacing 27mm, lead length 18mm.

Cat. RG-5176 Pkt 10 for **$7.95**

Cat. RG-5177 Pkt 100 for **$59**

2 New Boxes

SMALL GREY CONSOLE BOX

Cat. HB-6090

$9.95

ABS SEALED BOX

Addition to our range. This is now the largest in the range. Size 240x150 x90mm.

Cat. HB-6134

$29.95

NI-MH RECHARGEABLE BATTERY BREAKTHROUGH!!

•No memory effect •Higher current capacity
•High drain performance •And now - Lower prices.

AAA 550MAH
Previously Ni-cads were 280MAH
NIPPLE Cat SB-2430 **$4.50ea**
SOLDER TAG Cat SB-2431 **$4.75ea**

AA 1000MAH
NIPPLE Cat SB-2455 **$4.25ea**
SOLDER TAG Cat SB-2457 **$4.50ea**

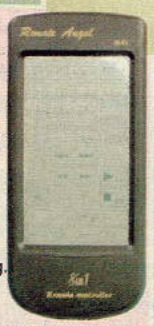
AA 1300MAH
NIPPLE Cat. SB-2438 **$5.25ea**
SOLDER TAG Cat SB-2439 **$5.50ea**

SUB C 2500MAH
SOLDER TAG Cat SB-2432 **$9.95ea**

C SIZE 3300MAH
NIPPLE Cat SB-2433 **$12.95ea**

D SIZE 7400MAH
NIPPLE Cat SB-2434 **$27.95ea**

Remote Angel Remote Control with Backlight



This must be the ultimate remote control! It is a learning remote control and will operate up to 8 pieces of equipment. It is quite unique in as much as it has a different LCD display for each piece of equipment its controlling. There are 28 programmable visual keys for each individual component. You can teach any command key, any function in each of the 8 devices. AR-1725

Cat. Price $179.50 Save $20

Feb. $159.50

Preprogrammed & Programmable Remote Control

SAVE $20

This easy to use control does it all. Suitable for TV, Video, VCR, Hi-Fi, Satellite, Teletext. Controls up to 4 units. •Preprogrammed with a huge up to date range of codes. •Learning Capability. This learning function allows you to add these odd functions into the remote. Other features include: •Glow in the Dark •Punch Through •Secondary Function •Anti Shock •Requires 4 x AAA batteries (not supplied). Cat. AR-1705

Was $89.95 **Feb $69.95**

Home Theatre Speakers

See Cat. page 44 for details.

CENTRE SPEAKER

Cat. CS-2515

Deal #1

Was $149 Save $20

Feb $129

REAR SPEAKERS

Deal #2

Cat. CS-2518

Were $165Pr Save $20Pr

Feb $145Pr

BUY BOTH TOGETHER **Deal #3**

	WAS	SPECIAL
CENTRE	$149	$129
REAR	$165	$145
	$314	$274

SPECIAL DEAL $249 THE LOT

Mini Analogue PIR

See 98 Cat. page 79 for full details. Curtain and long range lens available.

Cat. LA-5020

Was $34.95ea.

Feb. $29.95ea

Buy 5 $27.95ea

Pulse

Digital Thermometer With Min / Max Day Date, Memory & Time

This thermometer displays the time (24 hour mode) and inside and outside temperatures in its normal mode. It has a memory which holds the maximum and minimum temperatures reached and the time this happened. Outside temperature probe is on 3 metres of cable.

Cat. QM-7210 **Was $34.95**

Save $10.00 **Feb $24.95**

WIRELESS INDOOR OUTDOOR THERMOMETER

Main unit will support up to three main sensors, with high/low alarm for each, min./max. reading (-5°C to 50°C). Remote sensors are splash proof, have their own display, and can transmit up to 30m. The main unit is supplied with one sensor.

WIRELESS IN/OUT THERMOMETER Cat. QM-7220 **Was $119** **$99**

EXTRA REMOTE SENSORS Cat. QM-7221 **$49**

OVERNIGHT DELIVERY

OVERNIGHT DELIVERY

SAVE $$$ ON LEDS

DESCRIPTION				CAT	WAS	NOW	10 FOR
3mm	Red	120mcD	Clear	ZD-1752	$0.65	$0.40	$2.00
3mm	Red	900mcD	Clear	ZD-1753	$1.00	$0.70	$5.00
3mm	Yellow	2000mcD	Clear	ZD-1754	$1.65	$1.00	$7.00
3mm	Green	350mcD	Clear	ZD-1755	$1.25	$0.75	$5.00
3mm	Blue	500mcD	Clear	ZD-1756	$3.95	$3.00	$20.00
5mm	Blue	3000mcD	Clear	ZD-1776	$12.95	$9.95	$70.00
5mm	Green	2200mcD	Clear	ZD-1784	$7.95	$5.00	$35.00
5mm	White	4000mcD	Clear	ZD-1788	$9.95	$7.50	$60.00
5mm	Blue	1200mcD	Clear	ZD-1790	$4.95	$2.50	$20.00
5mm	Yellow	3000mcD	Clear	ZD-1791	$1.65	$1.00	$6.00

WALK BY LIGHT

PIR turns a light on when you walk by. Great for parents in a dark house at night! Requires 4 x D size cells. See cat page 81 for details. Cat. LA-5140

~~was $32.95~~
Save $12.95
Feb $20

HALOGEN LAMPS CRAZY PRICES

MR16 HALOGEN LAMPS
Normally $5.50ea with a glass cover, these do not have the cover. Pay up to $8 in the lighting shops for these. Limited quantity available. Be quick. Three types available.

1) **Large 51mm 12V 20 Watt 38°** Cat. SL-2790
2) **Large 51mm 12V 50 Watt 38°** Cat. SL-2792
3) **Small 35mm 12V 20 Watt 38°** Cat. SL-2793

only $3.95ea

REFLECTOR SECURITY BEAM

NEW MEM

This security beam uses infra red (IR) which is transmitted to a reflector and back again across a doorway. If the beam is broken by anyone, the buzzer will sound, and only sound while the beam is broken. It is ideal for shops, offices and storerooms etc. to warn of a visitor. The buzzer is on the end of 20 metres of cable, which can be run out the back to the office. The range is up to 7 metres. The transmitter plugs into mains power through a plug pack adaptor (supplied).
Cat. LA-5192 **Only $119**

LASER MODULE

NEW MEM

Ideal for experimentors. Includes laser diode mounted on a PCB with a battery spring and on/off switch. Simply connect a 3V battery - negative to spring, positive to case, and you have an experimentrrs laser.
1mw output. Cat. ST-3115
$14.95

Military Gas Torch

NEW MEM

This Pocke Torch lighter runs on butane gas. The case is clear and it has a piezo start. The flame is adjustable and can be locked off or on. Supplied with a cap on a chain. Height with cap is 76mm.
Cat. TS-1684 **Only $29.95**

SECURITY BEAM WITH TRANSMITTER AND RECEIVER

NEW MEM

This security beam is similar to the reflector type LA-5192, the difference being it has a receiver unit instead of the reflector. The receiver unit allows the effective range to be as much as 20 metres. This makes this unit suitable for warehouses with large doorways etc. Supplied ready to go with 20m of cable connecting the transmitter & receiver, & 20m of cable for the buzzer. Mains plug pack supplied. Cat. LA-5194
Only $139

MOBILE BABY MINDER

NEW MEM

$69.95

The transmitter (in the baby's room) plugs into the mains power and transmits to the receiver which is mobile. So you can take it with you outside & still monitor the baby.
Cat. AI-5540

LASER LEVEL

NEW MEM

This laser pointer level will allow you to check levels and lines in a radius of up to 10 metres. Comes in a aluminium case with a spirit level, screw thread for tripod mounting and 2 magnets to attach to steel structures for use on various angles. Ideal when levels are required for bricklaying, pipelaying, setting windows etc., etc. Size 145(L) x 34(H) x 18(W)mm. Supplied in carry pouch.
Cat. ST-3110 **$139**

MINI SCALE

0.1g Resolution

This digital scale measures from 0-50g with resolution of 0.1g and from 50-100g with a resolution of 0.2g and has a max. capacity of 100g. It also features a tare/net weight function and auto power off. Amazing small size-only 146L x 80W. Calibrated in Australia. Supplied in a pouch.
Cat. QM-7248 **$199**

NEW MEM

PIR CCD CAMERA

This is a motion activated camera. When the PIR detects someone, the CCD camera is switched on, and an alarm output is triggered (N/O and N/C 30VDC 0.5A) as well as a light output control (N/C 500W 2.5A).
The turn on time is adjustable, PIR is pulse count - range is 12mt. 110°. Not suitable for outdoors. Size 125(H) x 68(W) x 42(D)mm.
Cat. QC-3478
Only $199

NEW MEM

SYNCHRONOUS MOTOR DEAL

This small motor is rated at 220V 50Hz and 250RPM. Size is 51 (dia.) x 12 (H) mm. Spindle is 5mm long & 1.4mm dia.
Ltd quantity available. Cat. YM-2702
Only $5 each

1 Farad Car Audio Capacitor

See 98 Cat, page 64 for details. Cat. RU-6750
Was $199
Feb. $179
Save $20

Digital Display

Was $119
Feb. $99
Save $20
RU-6751

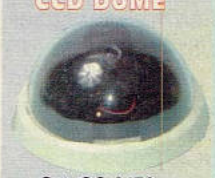
DUMMY DOME SECURITY CAMERA

This dummy dome camera looks exactly like the real thing, at a fraction of the price. Make your business /home/office look like its under surveillance. (Even includes the metal camera case inside). Cat. LA-5315
Only $39.95

NEW MEM

LOWER PRICES ON CCD CAMERAS

CCD DOME



Cat. QC-3472
Was $139
Now $129

BOARD

Cat. QC-3460
Was $125
Now $109

PINHOLE

Cat. QC-3461
Was $125
Now $109

METAL CASE PINHOLE

Cat. QC-3471
Was $145
Now $129

METAL CASE

Cat. QC-3470
Was $145
Now $129

REAL DOME CAMERA
Cat. QC-3472 **$129**

EMAIL ORDERS

mailorders@ jaycar.com.au
EMAIL YOUR ORDERS NOW

OVERNIGHT DELIVERY

IEC Double Socket Power Lead

NEW

3 pin mains plug to 2 x IEC female plugs. Length 1.85 metres. Ideal to run a computer and monitor from one power point. SAA approved.

Cat. PS-4102 **$14.95**

BARGAIN CD-R's

JAYCAR BLUE
Supplied in jewel case
Cat. XC-4712
$2.95 or 10 for $26.50
100 for $250

BLUE - BULK
Supplied in bulk pack of 10. No cases.
Cat. XC-4714
Pkt 10 $25.95
10 Pkts (100 CD's) $233.60

PHILIPS GREEN
Supplied in jewel case
Cat. XC-4711
$3.50 or 10 for $29.50

RICOH GOLD
Supplied in jewel case
Cat. XC-4710
$4.50 or 10 for $37.50

ITS HERE!!

NEW

Well, it should be here when you read this.

20 AMP 24 TO 13.8V REDUCER

See Cat. P96 for full details.
Cat. MP-3065 **$159**

EQUATOR CAR ALARM SALE

Equator 260 - What you get.
•Black box electronic module with all the features, see our 98 Cat. page 75 for details. Plus •2 transmitters •Ignition cutout relay •Shock sensoe •Wiring •Mini size siren. Cat. LA-8940

Was $219 Save $50!
Feb Only $169

PROFESSIONAL GRADE GARDEN LIGHTING

Large range of fittings and a choice of low-voltage lamps. All fittings are black in colour, made from die-cast high-grade material, and (unless noted) accept MR16 globes (not supplied).

HIGHLIGHTER

Cat. SL-2772 **$29.95**

FLOOD

Cat. SL-2770 **$29.95**

BURIAL TYPE

Cat. SL-2776 **$29.95**

STEP

Cat. SL-2778
$19.95

PAGODA

Cat. SL-2782 **$39.95**

PATH

Cat. SL-2780
$29.95

NEW

BRACKET & SPIKE

Cat. SL-2774 **$29.95**

BC GLOBES Size 300(H) excluding spike, dia. 140mm.
12V 15W Cat. SL-2721 $0.95
24V 20W Cat. SL-2719 $0.95
JC pin globes.
12V 20W Cat. SL-2722 $2.95
24V 35W Cat. SL-2723 $4.95

TOROIDAL TRANSFORMERS
To power your lights from mains power we suggest one of these in an enclosure:
150W (for 12V) Cat. MT-2112 **$56.95**
300W (for 12V) Cat. MT-2130 **$74.95**
160W (for 24V) Cat. MT-2114 **$56.95**
300W (for 24V) Cat. MT-2134 **$74.95**

MAGNIFYING GLASS HAND HELD

NEW

Only $5.95

Great for checking the value on small components such as caps & resistors. Consists of a high quality 62mm glass lens. Cat. QM-3535

TV Splitters

75 Ohm 2 Way
Cat. LT-3010
Was $6.50
Feb $4.50
Save $2

75 Ohm 3 Way
Cat. LT-3011
Was $7.50
Feb $5.50
Save $2

24V DC 500mA Plug Pack

NEW

Hard to get! 240VAC to 24VDC. Terminated to a 2.5mm DC plug.
Cat. MP-3029
Feb $17.95

Surround Speaker Floor Stands

Holds small speakers up to 185mm wide. Height adjusts 640-1250mm. Cat. CW-2850
Was $59.95Pr.
Feb. $49.95Pr.
Save $10Pr.

650 Cable Tie Can

Cat. HP-1208
Was $19.95
Save $5
Feb. $14.95

8" Woofer

Paper cone, rubber surround, power 30 WRMS. See 98 Cat. page 37 for full details
Cat. CW-2110 **Feb. $20**
Was $29.95 Save $9.95

Communication Mini Speaker

Power handling is 5 watts.
Cat. AS-3185
Was $14.95 Save $4.95
Feb. $10

Pack 'N' Latch Sellout

See 98 Cat. page 108 for details.
Cat. HB-6322
Was $39.95
Feb. $29.95
Save $10

10" Woofer

Paper cone, rubber surround, power 40 WRMS. See 98 Cat. page 38 for full details
Cat. CW-2119 **Feb. $25**
Was $34.95 Save $9.95

12" Woofer

Paper cone, rubber surround, power 550 WRMS. See 98 Cat. page 39 for full details.
Cat. CW-2125 **Feb $35**
Was $44.95 Save $9.95

MULTIMEDIA Microphone Deal

SAVE

Ideal for multimedia and voice recognition applications. Freq. response 20 - 16kHz. Impedence 600Ω. Flexible gooseneck.
Cat. AM-4082

Normally $14.95
Save $7.95
Feb. $7

TURN YOUR SURPLUS STOCK INTO CASH!

Jaycar buys surplus & distress stock of most electronic products from components to built products.
If you have marketable quantities of stock you need to clear contact Bruce Routley on
Phone: 02 9743 5222
Fax: 02 9743 2066

MAIL ORDER - FREECALL FOR PHONE ORDERS 1800 022 888

MAIL ORDER - FREECALL FOR PHONE ORDERS 1800 022 888

SAVE ON LEADS

VIDEO LEADS	LENGTH	CAT #	was	NOW	SAVE
BNC-BNC	1.5 M	AV-6510	6.95	4.95	2.00
RCA-RCA	3.0 M	AV-6519	7.50	5.50	2.00
BNC-RCA	1.5 M	AV-6521	6.50	4.50	2.00

TV LEADS	LENGTH	CAT #	PRICE $		
75Ω PLUG - PLUG	4.5 M	AV-6584	7.95	5.95	2.00

AUDIO LEADS	LENGTH	CAT #	was	NOW	SAVE
5 PIN DIN-DIN	1.2 M	WA-1000	4.95	2.95	2.00
5 PIN DIN-4 RCA	1.2 M	WA-1002	4.95	2.95	2.00
RCA PLUG-PLUG	1.2 M	WA-1016	2.95	1.95	1.00
2 RCA PLUG- 1 RCA PLUG GOLD	1.8 M	WA-1034	4.95	2.95	2.00
2 RCA PLUG- 2 RCA PLUG	3.0 M	WA-1044	6.95	4.95	2.00

Car Noise Suppression Bargains

Reduces alternator whine.

3 AMP Cat. AA-3070 **Was $7.95**
Save $3 **Now $4.95**
20 AMP Cat. AA-3075 **Was $17.95**
Save $5 **Now $12.95**
50 AMP Cat. AA-3078 **Was $36.95**
Save $12 **Now $24.95**

NEW ADAPTOR

D9 Female to RJ45 Female.
Cat. PA-0906 **$5.95**

WHAT A FLOP! Why Take The Risk??

RADIATION PHONE CASES

No one seems terribly interested in the fact that mobile phones may fry your brains! Now you don't have any excuses!

Only $5 each.

Microtac	Cat. HC-6920
Motorola 8200,8400	Cat. HC-6922
Motorola Flare	Cat. HC-6924
Motorola 8500,8700	Cat. HC-6926
Nokia 2110	Cat. HC-6930
Nokia 1610	Cat. HC-6932
Nokia 8110	Cat. HC-6934
Ericsson 318/388	Cat. HC-6938
Ericsson 738/788	Cat. HC-6940

8" WALL CLOCK NEW

Quartz timing with white face (Dia. 20cm) and black numbering.
Cat. XC-0110
$12.95

10" CLOCK WITH HUMIDITY & TEMPERATURE

Quartz timing with black face - 20cm dia & white numbering.
Cat. XC-0112 **$19.95**

SMALL SPEAKER DEALS

No. 1
4" (100MM) ROUND SPEAKER
4Ω 2 WATT.
Cat. AS-3009

Only $2
Buy 10 $1.60ea

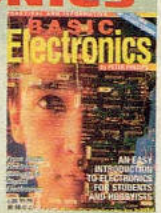
No. 2
5" (125MM) WITH SET BACK MOUNTING BRACKET
6 WATT 4Ω.
Cat. AS-3011

Normally $6.75
Only $3.50
Buy 10 $3.00ea.

8" 24 HOUR WALL CLOCK

Great for shift workers! Quartz timing with white face (Dia.20cm) and black numbering.
Cat. XC-0111 **$19.95**

BASIC ELECTRONICS



Brand new book from Electronics Australia. Learn about Electronics. Starts with volts, amps and ohms, then resistors, batteries, inductors, capacitors, diodes, power supplies, transistors, amplifiers and ends with an introduction to digital electronics. Stacked full of vital information for those interested in learning about electronics. Great price! 114 pages. Cat. BE-5050

Only $5.95

POWERTECH 12V, 15V,18V DC 800MA REGULATED SWITCHED POWER SUPPLY

Has switchable voltage and polarity. Output lead is 4 way moulded star plug which has 2.5mm & 3.5mm mini plugs & 2.1mm and 2.5mm DC plugs and a 1.3mm DC plug.
Cat. MP-3034 **$39.95**

RJ45 BOOTS

A pkt of 4 boots to suit RJ45 8/8 plugs. Includes 2 blue and 2 grey boots.
Cat. PM-1440
$1.98 PKT 4

SVHS LEADS

4 pin "S" Plug to " S" Plug. Gold connectors, 4 pins wired. 2 lengths available.

1.5m	3.0m
Cat. WA-1105	Cat. WA-1106
$9.95	$11.95

GME Kingray 4 WAY INDOOR TV/FM AMPLIFIER

Boost your signal for up to 4 TV's with this indoor mains powered booster. UHF gain is 10dB, VHF gain is variable. Made in Australia. Uses 75Ω TV sockets.
Cat. LT-3286 **$99.95**

BUDGET COMPUTER TOOL KIT

Includes •IC inserter •Blank hex driver •Reversable bits •T10/T15 driver bit •Phillips 0 & 1/8" slot bit •Phillips 1 & 3/16" slot bit •Nut drivers 3/16" & 1/4" •Spare parts tube •Pearl catch •Tweezers •IC extractor. Cat. TD-2039 $17.95

3 IN 1 DETECTOR

A quality tool that will find wooden studs, metal, nails, screws and voltage. When anything is detected, a LED will light up next to the corresponding symbol - and a buzzer will sound. Includes a 2 way switch, one position for studs, the other for metal and voltage. Also has a low battery warning. Uses a 9V battery not supplied. Size 175x38x23mm. Cat. QP-2280

Only $29.95

New Kits - New Kits

Digital Capacitance Meter Kit

Refer: Silicon Chip 2/99. For the most of us that find it hard to read the values on tiny capacitors, ceramics for example, this kit solves the problem. This versatile capacitance meter will measure capacitors from a few picafarads up to 2uF on a 3.5 digit LCD display. It can be powered from a 9V battery for portability, or from a plugpack for permanent workbench applications. Kit supplied with case, silk-screened front panel, PCB, LCD display, 9V battery and all electronic components. 12VDC or 9-12VAC plugpack required for permanent power option.
Cat. KC-5259 **$49.95**

Audio Signal Generator With Digital Frequency Readout

Refer: SC Feb. 99.
An Audio Generator is a general requirement for accurately testing and servicing audio equip-ment such as amplifiers and speakers. This audio generator will produce high quality sine and square waves between 10Hz to 100kHz in four ranges, and will display the output frequency on a 4 digit LED readout. The generator boasts very low distortion, fast settling time, sync output for an oscilloscope and stepped attenuator with fine adjustment. Ideal test gear for enthusiasts or technicians. Kit supplied full-form with case, professionally punched powder coated and silk screened front panel, punched rear panel, PCBs transformer and all elctronic components.
Cat. KC-5260 **$169.95**

AA FLAT NI-MH RECHARGEABLE BATTERY

These are the flat batteries used in the really thin cellular phone batteries. 1.2V 650mA. Quality Japanese cell. Cat. SB-2435

Were $10.50
Save $3
February $7.50

Valve Socket Assortment

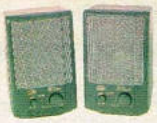
NEW ITEM

Your Lifetime Stash

Build that valve amp you've always dreamed about, or perhaps use them to restore an antique radio or HI Fi. We have accumulated stock from various sources to come up with a definative valve collection. (Valve sockets are hard to source, valves themselves are much easier to find). The stock was to go towards a valve amp kit project that we have now aborted. Each pack will contain at least 30 valve sockets ranging from 9 pin PCB & chassis mount types (over 1/2 the pack contents) to higher pin types. Some people may even get a 7 pin socket which was common in early battery valve sets. The pack is a great opportunity to source these hard-to-get componants at great prices. Stock is new and in excellent condition.

Cat. PS-2065 **$9.95**

Amplified Walkman Speakers



12 watts PMPO per speaker.
Use 4 C Batteries. Cat. CS-2425
Were $37.95 Save $10
Feb. $27.95Pr.

Large Computer Speakers

36 watts PMPO per speaker.
Includes mains power supply.
Cat. XC-5164
Were $59.95 Save $10
Feb. $49.95 Pr

Jumbo Computer Speakers

120 watts PMPO per speaker.
Includes 12VDC 2.5A power supply. Cat. XC-5165
Were $99.95
Feb. $79.95 Pair
Save $20 Pair

LCD Handheld CRO

See 98 Cat. page 30 for details.
Cat. QC-1905
Was $479
Feb. $399

SAVE $80

Dwell Tacho DMM

RPM x1, x10, Dwell angle, Resistance, DC volts, includes holster. Cat. QM-1440

Was $79.95 Feb. $59.95
SAVE $20

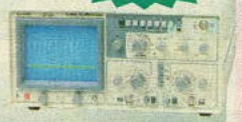
ADJUSTABLE 50MM DOWNLIGHT

NEW ITEM

Install your own professional halogen lighting system anywhere you like. Total width at front is 102mm and the depth is 39mm. This holder suits all of our 51mm 12V halogen lamps. Cat. SL-2739 **$9.95**

25MHz Dual Trace CRO

INCLUDES 2 PROBES



See 98 Cat. page 28 for full details.
Cat. QC-1900
Was $749
Save $120
February $629

HEAVY DUTY MAINS SURGE PROTECTOR

NEW ITEM

This protector is in a very heavy anodised steel case, and has 4 individually switched sockets and illuminated rocker switch. It features initial protection with a circuit breaker and spike reduction circuit, followed by two stage high frequency filtering for maximum protection. The black outlets have single stage filtering for less sensitive items such as printers and plotters, while the white outlets with 2 stage protection suit the computer and monitor. Made in Australia. SAA approved N11895. Size 440(L)x100(W)x50 (D)mm. Cat. MS-4015

LIMITED QUANTITY

Normally sell for $269 Save about $100 **These are only $165**

HIGH QUALITY TV/HI FI HEADPHONES

SAVE

Features 5 metre extra long cord with individual volume control, mono/stereo selector switch and a gold 3.5mm plug with gold 6.5mm adaptor. The headband is lightweight, fully adjustable and has cushioned ear pads. Cat. AA-2002

Normal Price would be $14.95
Only $9.95

Volume Control

LIGHTWEIGHT HEAVY BASS STEREO HEADPHONES

Designed for extra base performance. Fully adjustable headband and speakers for greater comfort. Supplied with 3.5mm plug and 6.5mm adaptor. Cat. AA-2007

Normal Price would be $19.95
Only $14.95

COMPUTER STEREO HEADPHONES

Fully adjustable lightweight headband with cushioned ear pads. Individual volume control with mono/stereo selector switch. Play a CD on your computer without disturbing others. Cat. AA-2034

Normal Price $14.95 Were $9.95
Feb $7.95

Volume control

5 MTR PRO OFC LEAD

Double sheilded with metal plugs and centre lead.

Cat. WA-1094

Was $34.95
Feb $20
Save $14.95

EMAIL ORDERS: mailorders@jaycar.com.au WHOLESALE EMAIL: wholesale@jaycar.com.au

Jaycar ELECTRONICS

HEAD OFFICE
8-10 LEEDS ST RHODES 2138
PHONE: (02) 9743 5222
FAX: (02) 9743 2066

Quality System — Quality Endorsed Company ISO9002 Lic 6143 Standards Australia

WHOLESALE
PHONE: (02) 9743 5222
ORDERS: 1800 620 169
FAX: (02) 9743 3070
FREEFAX: 1800 810 137

MAIL ORDERS FREE POST TO:
Reply Paid 72. Jaycar Mail Orders. PO Box 185 Concord NSW 2137 FREE CALL FOR ORDERS: 1800 022 888
ENQUIRY HOTLINE: (02) 9743 6144 FAX: (02) 9743 2066

ROAD FREIGHT ANYWHERE IN AUST (up to 20kg) $14.00

POST & PACKING $10 to $24.99=$4.00 $25 to $49.99=$5 $50 to $99.99=$7 OVER $100=$8

bankcard MasterCard VISA Diners Club International AMERICAN EXPRESS eftpos

VISIT OUR WEBSITE www.jaycar.com.au

ADELAIDE SA •191-195 Wright St (Cnr. St. Lukes Pl.) •Ph:(08) 8231 7355 •Fax:(08) 8231 7314 •Mon/Fri:9-5.30 •Fri:9-8.30 •Sat:9-4

BURANDA QLD •144 Logan Rd •Ph:(07) 3393 0777 •Fax:(07) 3393 0045 •Mon/Fri:9-5.30 •Thurs:9-8.30 •Sat:9-4

ASPLEY QLD •1322 Gympie Rd, cnr Albany Creek Rd •Ph:(07) 3863 0099 •Fax:(07) 3863 0182 •Mon/Fri:9-5.30 •Thurs:9-8.30 •Sat:9-4

CANBERRA ACT •121 Wollongong Street, Fyshwick •Ph:(02) 6239 1801 •Fax:(02) 6239 1821 •Mon/Fri:9-5.30 •Sat:9-4

MELBOURNE CITY •Shop 2,45 A'Beckett St •Ph:(03) 9663 2030 •Fax:9663 1198 •Mon/Fri:8.30-5.30 •Fri:8.30-8.30 •Sat:9-4 •Sun:10-4

COBURG VIC •266 Sydney Rd •Ph:(03) 9384 1811 •Fax:(03) 9384 0061 •Mon/Fri:9-5.30pm •Fri:9-8.30 •Sat:9-4

SPRINGVALE VIC •887-889 Springvale Rd Mulgrave. Nr Cnr. Dandenong Rd •Ph:(03) 9547 1022 •Fax:(03) 9547 1046 •Mon/Fri:8.30-5.30 •Fri:8.30-8.30 •Sat:9-4 •Sun:10-4

HOBART TAS •140 Campbell St, Hobart •Ph: (03) 6231 5877 •Fax:(03) 6231 5876 •Mon/Thur:9-5.30 •Fri:9-7 •Sat:9-4

SYDNEY CITY •129 York St •Ph:(02) 9267 1614 •Fax:(02) 9267 1951 •Mon/Fri:8.30-6 •Thurs:8.30-8.30 •Sat:9-4 •Sun:10-4

BANKSTOWN •363 Hume Hwy Cnr Meredith •Ph:(02) 9709 2822 •Fax:(02)9709 2007 •Mon/Fri:9-5.30 •Thurs:9-8.30 •Sat:9-4 •Sun:10-4

GORE HILL •188 Pacific Hwy Cnr. Bellevue Ave •Ph:(02) 9439 4799 •Fax:(02)9439 4895 •Mon/Fri:9-5.30 •Thurs:8.30 •Sat:9-4 •Sun:10-4

PARRAMATTA •355 Church St (Cnr. Victoria Rd) •Ph:(02) 9683 3377 •Fax:(02) 9683 3628 •Mon/Fri:9-5.30 •Thurs:9-8.30 •Sat:9-4 •Sun:10-4

PENRITH •199 High St •Ph:(02) 4721 8337 •Fax:(02) 4721 8935 •Mon/Fri:9-5.30 •Thurs:9-8.30 •Sat:9-4 •Sun:10-4

RHODES •8-10 Leeds St •Ph:(02) 9743 5222 •Fax:(02) 9743 2066 •Mon/Fri:9-5.30

NEWCASTLE •990 Hunter St. (Opp. Selma Street) •Ph:(02) 4965 3799 •Fax:(02) 4965 3796 •Mon/Fri:9-5.30 •Sat:9-4

PERTH •326 Newcastle St Northbridge •Ph:(08) 9328 8252 •Fax:(08) 9328 8962 •Mon/Fri:9-5.30 •Thurs:9-7.00 •Sat:9-4

NZ •Mon - Fri: 9-5.30 Sat: 9-5.30

*OVERNIGHT DELIVERY AVAILABLE ON REQUEST
Subject to conditions: •Max weight 3KG (inc cubic) $10 •No dangerous goods •Max weight 5kg (inc cubic) $16
•Stock & availablity •Orders must be received before Midday E.S.T.

NEW JAYCAR STORE IN NEW ZEALAND •14A Gillies Ave. Newmarket. Auckland •Ph: (09) 529 9916
MAIL ORDERS: P.O. Box 9667. Newmarket. Auckland. FREE POST: 104345

PRODUCT SHOWCASE

Digital thermometer reads to 1370°C

Need to read very high or very low temperatures? Dick Smith Electronics have a compact, hand-held dual input digital thermometer with a range of -200°C to +1370°C. Temperature limits can be preset with an alarm beeper sounding if the temperature exceeds those limits.

Other features include auto power off, data hold, dual temperature and temperature differential displays and minimum/maximum temperature and time recording.

An attached protective holster is supplied, as are K-type thermocouples which have a range of -40°C to 260°C. Other thermocouples are required for the maximum instrument range measuring to 1370°C.

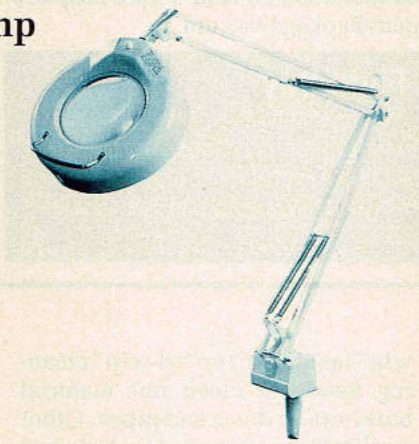
The instrument sells for $155 at all Dick Smith Electronics stores (Cat. Q-1437).

For further information contact Dick Smith Electronics, Lane Cove & Waterloo Rds, North Ryde NSW, 2113. Phone (02) 9937 3200; fax (02) 9888 1507.

Desk-mount magnifier lamp

Jaycar Electronics have available a metal frame magnifier with an inbuilt 22W circular fluorescent lamp. It is intended to assist hobbyists, PCB assembly/inspection, jewellers, stamp/coin traders, etc.

The magnifier itself is a 3-diopter lens, mounted on a flexible extension arm assembly extending to 990mm.

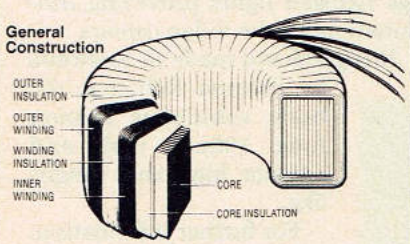


The base can be screwed onto the side of any desk or workbench (approximate allowable table top thickness is 45mm).

The lamp can be turned on or off by a head-mounted switch connected to a 2-metre length mains cord and plug. Replacement tubes are readily available from most lighting stores.

For more details on the Desk Mount Magnifier Lamp (QM-3525) contact any Jaycar Electronics store or call Jaycar Electronics, 8-10 Leeds St, Rhodes, NSW 2138 Phone (02) 9743 5222, fax (02) 9743 2066

TOROIDAL POWER TRANSFORMERS



Manufactured in Australia
Comprehensive data available
Harbuch Electronics Pty Ltd
9/40 Leighton Pl. HORNSBY 2077
Ph (02) 9476-5854 Fx (02) 9476-3231

Barcode-based inventory control

Snap-on Tools has introduced an inventory and tool control system which it says will cut down on lost or missing tools, reduce hoarding of tools and equipment, increase staff and contractor productivity and reduce downtime.

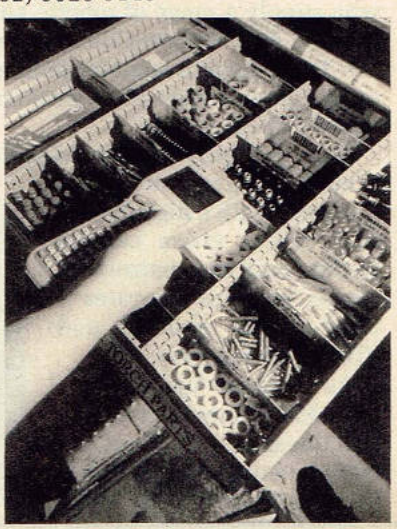
The Windows-based "Tool Hound" system controls the issue and return of inventory items in which large companies, government departments and the like have millions of dollars invested.

Tools, consumables, parts and equipment can all be controlled by the laser-based barcode scanning system incorporated in Tool Hound.

The system is said to virtually eliminate the paper trail and delays of a manual system. This ensures nothing "falls through the cracks" because the system knows where everything is at any time.

The Windows-based system can track an unlimited number of inventory items, people and locations. It gives up-to the-minute status reports and can incorporate radio frequency communications, providing "real time" inventory control.

For more information, contact Snap-on Tools (Aust) Pty Ltd, 6/100 Station Road, Seven Hills, NSW 2147. Phone (02) 9837 9130; fax (02) 9620 9145

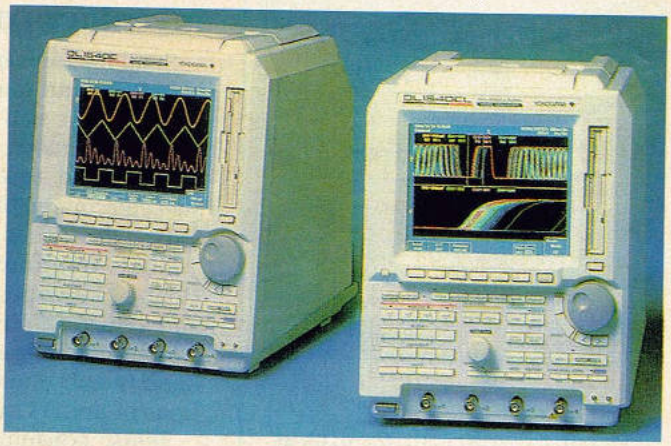


Portable colour oscilloscopes from Yokogawa

Not many of us put up with monochrome TV these days – so why put up with a monochrome oscilloscope?

Yokogawa has two lightweight portable scopes which have a DC-150MHz analog bandwidth, four input channels, a maximum sampling rate of 200MS/second ... and 6.4-inch colour TFT displays.

There are two models, the DL1540C and the DL1540CL, the latter being a long-memory model. The "C" model can capture signals using a record length of 120Kword, while the "CL" stores signals up to 2Mword.



Both feature a zoom function which can display up to eight traces simultaneously with the captured trace and zoomed trace able to be displayed at the same time.

They also have a "history" function which allows the last 100 displays to be recalled.

A built-in floppy disc drive allows waveform data, panel setting information and screen dumps to be saved for later use. Screen images can be output in HPGL, PostScript, TIFF and BMP formats. Printing of colour screen images is also possible using an external colour printer connected via a GP-IB/Centronics adaptor.

Also available is an optional built-in thermal printer.

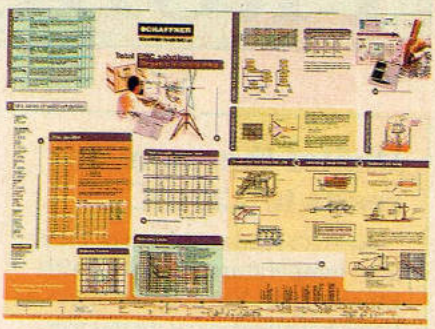
For further information, contact Yokogawa Australia on (02) 9805 0699; fax (02) 9888 1844 or e-mail measurement@yokogawa.com.au

Central Coast Amateur Radio Field Day

Just a reminder: Australia's largest field day, with new and used radio and communications equipment for sale, is on Sunday, February 28 at Wyong Race Course, Howarth Street, Wyong.

Wyong station is an easy walk away. For further information, contact the Central Coast Amateur Radio Club's website, www.ccarc.org.au, or call the club on (02) 4340 2500.

Free EMC wall chart for labs and test centres



A highly informative wallchart covering emission standards and methods for RF radiated electromagnetic compatibility is now available free of charge from Westek Industrial Products.

Westek is the Australian distributor of Schaffner-Chase EMC Instrumentation.

This is the first in a series which will cover all aspects of testing to EMC standards.

The chart is intended for laboratories or test offices where EMC testing is carried out.

Along with the scope and required tests and equipment for the common, worldwide commercial standards, the chart covers emission limits and technical data such as field strength conversion tables.

For your copy, or more information, contact Westek Industrial Products Pty Ltd, Unit 2, 6-10 Maria Street, Laverton North, Vic 3026. Phone (03) 9369 8802; fax (03) 9369 8006

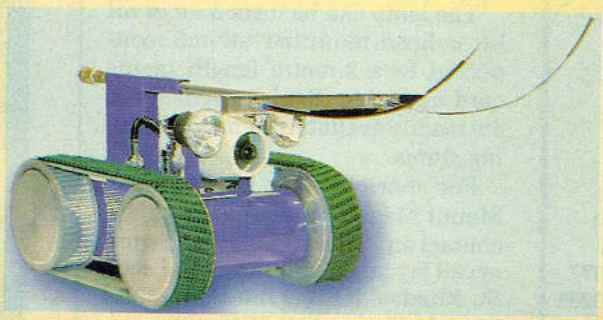
What a rat!

World of Robotics, the people who supply a range of robotic kits to build (see SILICON CHIP December 1998) have available another rather interesting robot product called "The Duct Rat".

It is a highly manoeuverable visual inspection robot equipped with a high resolution colour video camera feeding back to a control unit which also incorporates a Sony colour monitor and VHS video recorder.

As its name suggests, the Duct Rat is intended for inspecting ducts and pipes, detecting faults and damage. It can also be fitted with "dual-wip" (as shown) or "tri-wip" cleaning heads to clean out material build-ups in ducts and pipes. Other applications suggested include law enforcement and investigation of hazardous areas or materials.

Fitted with tank-track (belt-type) drive, the Duct Rat is "driven" from the control panel via a 22-metre cable. It is operated by low voltage for operator safety, with low voltage halogen lights providing illumination for the video camera.



Designed and made in Australia by Stanton Robotics, the basic vehicle is 264mm long, 166mm wide and 145mm high and weighs 5kg.

For further information, contact World of Robotics, 110 Mt Pleasant Rd, Belmont, Vic 3216. Phone (03) 5241 9581; fax (03) 5241 9089; e-mail frances@mail.austasia.net

Yamaha's new home theatre A/V receiver

Yamaha's new "flagship" receiver, the RX-V2095, has no less than seven channels of amplification – five at 100W each for home theatre and 2 x 25W for effects channels.

Intended for state-of-the-art home theatre applications, the receiver features Tri-Field /Duo-Field Cinema DSP, HiFi DSP, DTS Digital Surround and Dolby Digital processing.

It incorporates 36 surround sound field programs that handle eveything from movies, music videos and sports programs along with six hifi DSP programs based on data from actual performance venues.

Analog inputs are provided for phono, CD, tape/MD, DVD/LD, TV/DBS, 2x VCRs and Video Aux. Digital inputs are provided for CD (both coax and optical) and Tape, DVD/LD and TV/DBS (all optical). Composite video and S-video inputs are catered for with DVD/LD, TV/DBS, 2 x VCRs and Video Aux. Outputs include extensive speaker configurations, preamp outputs, a composite video monitor output and a mono sub-woofer output.

In addition, the RX-V2095 offers an impressive range of system connection options.

Two remote controls are included: a multi-command learning-capable remote control for the main listening area plus one for a second zone.

The main zone and second zone can simultaneously access different audio sources.

The RX-V2095 is available in two finishes: black, with a recommended retail price of $2999 and gold at $3299. Both have similarly styled cases and feature on-screen displays.

For further information, contact Yamaha Music Australia, 17-33 Market St, South Melbourne Vic 3205. Phone (03) 9693 5111; fax (03) 9699 2332. Information is also available at www.yamaha.com

Compact JBL home theatre speakers

With a size of just 140 x 254 x 156mm (w x h x d), the new HLS410 2-way compact speakers from JBL are the smallest member of the JBL HLS range.

Rated at 8 ohms, and with a frequency response (±3dB) of 75Hz to 20kHz, the speakers suit amplifiers in the 15-100W power range. Sensitivity is 86dB (2.83V @ 1m).

The woofer is a 100mm co-injection moulded model while the tweeter is a 10mm polycarbonated dome type attached to a constant-directivity horn. Crossover is at 3kHz.

The speakers are claimed to be suited for use as rear speakers in a home theatre system or as the front left and right speakers.

Shielding allows the speakers to be safely placed near a TV set in an A/V system.

For more information, contact the Australian distributor for JBL speakers, Convoy International Pty Ltd, Phone (02) 9700 0111; fax (02) 9700 0000, e-mail hifi@convoy.com.au, or visit the Convoy website, www.convoy.com.au

Jaycar distributes Vulkan gas soldering tools

Jaycar Electronics have been appointed the exclusive Australian distributor for the professional "Vulkan" range of gas-powered soldering tools.

The Vulkan cordless gas soldering iron can deliver the equivalent of a 135W electric iron. It is made in Ireland from a lightweight plastic and weighs just 110 grams. The iron uses catalytic conversion for most of its applications.

Fuel is standard butane gas, stored in the tool's translucent handle for level indication. Each refill provides three hours continuous use at a typical setting for electronics soldering.

Gas flow is adjustable for a tip temperature of 400°C to 1200°C.

The Vulkan iron has a 12 month warranty and is available in two forms – a stand-alone version (tool, cap and 2.4mm chisel tip), Cat No TS1200 selling for $89.00, or as a $129 professional tool kit (quality plastic case, stand, soldering tool, flame tip, hot blow tip, deflector for hot blow, hot knife tip, cleaning sponge, two metal storage trays, cap and 2.4mm soldering tip), Cat No TS-1205.

A range of tips and accessories is also available.

For more information, contact Jaycar Electronics, 8-10 Leeds St Rhodes NSW 2138. Phone (02) 9743 5222; fax: (02) 9743 2066

SERVICEMAN'S LOG

The set that languished & died

Some customers get rather attached to their TV sets, particularly if they've given years of trouble-free service. Fortunately, a full military service isn't usually necessary.

My main story this month concerns an NEC FS6325 63cm TV set. At first glance, this looks like a stereo TV set, with its twin speakers and left and right input sockets, but it doesn't have a stereo decoder.

If anyone wants the stereo feature, they would have to do what the Wilsons had done – purchase a hifi VCR and use the AV leads to get the full effect. However, the TV set had failed. It had apparently been "languishing" for some time before finally passing away completely during the night.

Mr Wilson wanted to know whether it should be buried with full military honours because it was now getting on a bit, or could I perhaps "perform a Lazarus"? After all, it had been a good set.

In the past, I have repaired several TV sets of this series. These are genuine NEC sets (ie, made by NEC) and, generally speaking, are very reliable. The genuine NEC sets are easily identifiable as they use a PWC number for each printed wiring board. In this case, the main board was PWC 3517.

Most of the problems that do crop up are associated with dry joints to the power diodes on the secondaries of the horizontal output and chopper transformers. For this reason, I felt relatively confident that the set could be fixed on the spot and arranged to make a house call that afternoon.

In due course, I settled myself behind the set and, with the help of an electric screwdriver (how did I manage before I acquired this?), made short work of releasing the back. Access to the underside of the main board is rather tricky until some of the wiring harness is unplugged. When I did this, I was relieved to see that my diagnosis was spot on and resoldered a very dry joint to D621 (which supplies the 130V rail). I also checked D522 in the 12V rail but it was OK.

I was so confident that I had fixed the problem that I replaced the back and returned the set to its original position before switching it on. Unfortunately, my confidence was short-lived. It did come on for a few seconds but then, much to my disgust, it died again.

Hoping that this was just a temporary aberration, I tried switching it off and on again. This time, the picture and sound came on for half a minute before going off. Was this what Mr Wilson meant by "languishing" before it died? "Well, sort of", he replied.

Apparently, they had been forced to switch it off and on a number of times before it would stay on. It's problems like this that put a complete downer on your day. I hadn't counted on this and I had other appointments to keep. My options were either to delve back into the set or take it to the workshop.

One last effort

I decided to remove the back again. I looked around for dry joints and resoldered a few suspects but nothing really caught my eye. In the fault condition, the multimeter indicated 130V on the collector of Q502 (the horizontal output transistor) and also on its driver transistor Q501. The 130V on Q502 was OK but not on Q501. If this was functioning normally and drawing normal current, its collector should have been around 54V. And that told me that the horizontal oscillator, embedded somewhere in IC701 and coming out on pin 6, was not functioning.

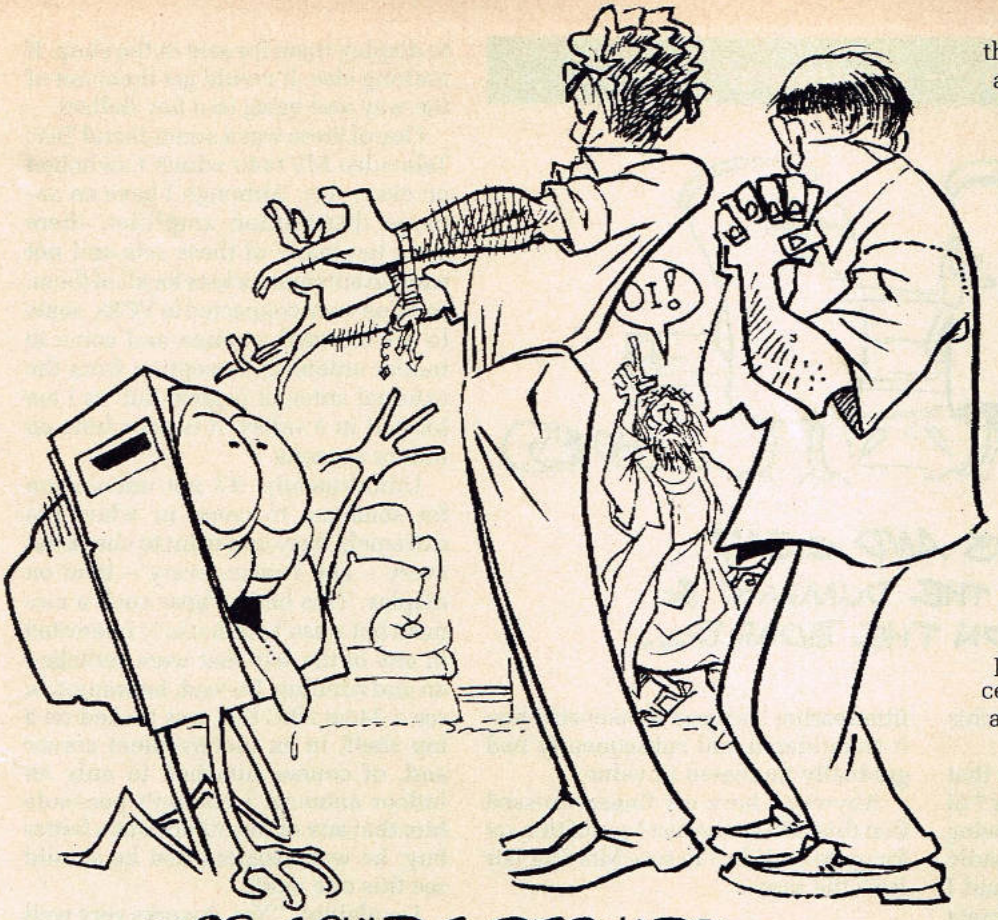
By now, it was obvious that I was going to be late for my next appointment and so I quickly checked the other rails. The 28V rail for the sound was OK and so were the 17V and 5V rails. But that was as far as I could go for the time being; the set would have to go back to the workshop. I quickly cleaned up, cleared some space in the truck and carried the set out. Fortunately, this set only weighs about 30kg.

The next day, I tackled the set again as soon as I had my compulsory coffee fix. I tried tapping the chassis, heating and freezing but it made no difference and I was now quite sure that this wasn't a dry-joint fault. I followed the 12V rail via R599 to an 11V zener diode, then on to pin 8 of IC701 via D598. This is the soft start-up voltage, to fire the oscillator before it is taken over by the 12V rail via D599. The zener diode – ZD501 (13V) – checked out OK.

It was time to review the situation. At the moment of switch-on, the entire set was apparently working OK. However, after a few seconds, something was shutting down the oscillator and the voltage on pin 8 of IC701 dropped dramatically. One possibility was that the microprocessor on the CPU board was at fault, as it supplied the sync input to pin 16 of IC701.

Some sets have an arrangement whereby the set will switch off automatically after a few minutes when a TV station closes down at night. This is done by using a timer on the sync input to the jungle IC, which cuts off the horizontal oscillator. In this case, I felt that this was unlikely as the set rarely stayed on for more than a minute.

It was only then that I noticed (and recognised from the old Rank Arena days) transistors Q2001 and Q2002 in an x-ray protection circuit. This cir-



~OR COULD I PERHAPS PERFORM A LAZARUS..?

cuit shuts off the drive to Q501's base if the pulses from the horizontal output transformer, T502 pin 2, go too high (Q501 is the horizontal driver transistor). And I remembered how much trouble this little circuit used to cause. The transistors became leaky, their gain was critical and there were modifications that had to be done to the early versions.

I shorted test point TP2001 to chassis to disable the protection circuit and the set stayed on indefinitely, so I was at least on the right track. Unfortunately, after spending over half an hour checking all the components in this safety circuit I couldn't find anything wrong. Finally, I put the CRO onto pin 2 of the horizontal output transformer (T502) and checked the waveform. As luck would have it, the set now stayed on permanently with or without TP2001 connected to chassis.

I left the set on test and went on with something else. Every so often on my way to the kettle for a slurp at my life support, I glanced at the set and the CRO but everything was still going fine. Eventually, I needed the CRO for another job and so the NEC was left alone, still switched on. Once or twice, I think I noticed the width vary momentarily but it may have been an optical illusion.

Anyway, this went on for well over a week and a rather petulant Mr Wilson was now phoning quite frequently, wanting to know when Lazarus could come home. I told him the truth which was a mistake, as he was singularly unimpressed. Eventually, we finally agreed that I would deliver it if it was still working after one more week.

The day before delivery, the weather turned damp and when I switched the set on that morning, it coughed and died. I'm afraid I called it a few nasty names but at least it had failed before I'd delivered it to the customer. I reconnected the CRO and this time I watched the waveform before it died and I noticed it was getting really large.

With TP2001 shorted to chassis again, the set stayed on and though the waveform was initially large and varying, it settled down. Obviously here was the problem but was it the horizontal output transformer or a problem with the EHT regulation? I put the second channel of the CRO on the collector of Q502 (pin 10, T502) and noted that although the secondary waveform on pin 2, was varying, the primary on pin 10 wasn't. This was all I needed to condemn the horizontal output transformer.

I phoned Mr Wilson with the good news that I had found the fault. The bad news, of course, was the need to replace T502, its cost, and the time taken to order the replacement. He reluctantly accepted the reality of the situation and a new one was ordered.

From then on, it was plain sailing. The transformer arrived in a few days, was duly fitted and the set returned. So far I haven't heard any more from it or the Wilsons.

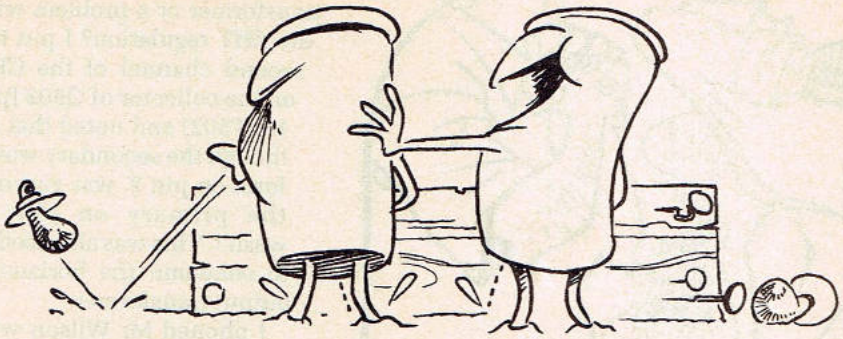
The white line

Mrs Sinclair's Toshiba 289X9M arrived unannounced while I was out, with a note attached describing the fault as a "white line across the screen; was intermittent, now permanent".

Interestingly, the set modestly advertises that it can handle 18 different TV systems. I didn't even know there were that many in use. However, I suppose if one adds up all the small differences, combinations and permutations between each country it could be that many. The last list I saw included CCIR system M, which made 13 systems – obviously there must be at least five newer ones since then. Australia has the peculiar distinction of having two systems: CCIR B and G (one system for VHF and another for UHF).

Anyway, I digress. I was hoping the fault might be attributable to dry joints on the vertical output IC (IC303).

Access to the chassis – especially the vertical timebase – was very poor. However, my diagnosis was correct. IC303 had several dry joints and I hoped that resoldering would be all that was necessary. Unfortunately, I was too late; the fault was now perma-



nent, the set having been run in this condition for too long.

It didn't take long to work out that there was no voltage reaching pin 7 of IC303 and this was due to R327 being open circuit. In fact, it was so badly burnt I couldn't read its value and I didn't have a circuit for this exact model. I did, however, have circuits for the 289X7M and 289X8M models but they each had a different value for this part, one indicating 8.2Ω and the other 4.7Ω. I chose a 10Ω resistor as, at the time, I didn't have anything smaller. At switch-on, this component began to smoulder, indicating a probable short in IC303.

I replaced the IC and at last had a picture and the resistor ran cool. The linearity was poor and this was attributable to two red electrolytic capacitors. Both C303 (1µF, 50V) and C317 (2.2µF, 50V) had spat the dummy and leaked onto the board. After cleaning up the corrosion and fitting new 105°C capacitors, the picture was at last perfect. I left it on soak test for a day or two before the lady picked it up.

However, that wasn't the end of the story. A week later it magically reappeared, with another note saying that there was a kink in the picture about two-thirds of the way up the screen. Disappointed, I rechecked and replaced everything I had done, just in case but it wasn't until I replaced the previously replaced R327, this time with a smaller value (4.7Ω), that the fault was finally cleared. I can only surmise that the 10Ω resistor I had fitted earlier had been weakened when it smouldered and subsequently had gradually increased in value.

Anyway, I have my fingers crossed that this will be the last I see of this set for quite a while. I'm sure Mrs Sinclair feels the same.

A write-off

Mr Berry was very distressed; someone had broken into his house and tried to steal his TV set. I say tried because the thief found that the window was too small for the Philips 25GX1885 59cm model (Anubis BB chassis) that he was trying to steal. So in true caring style, the robber dropped the set about a metre from the window sill to the concrete floor and then made his escape. Amazingly, the set still worked but the case was cracked and the tube had a deep scratch in it.

Fortunately, the set was insured so I checked the replacement prices: $185 for the cabinet and $1035 for the tube. The set only cost $999 new, complete in its box, and the insurance company took the logical option to replace it with a new set.

So that let me off the hook. And, in any case, I wouldn't want a scratched picture tube hanging around the shop until it had been let down to air. I have seen what an imploding tube can do when it goes off.

Secondhand sets

And now for a change of pace. Some time ago, I accumulated a number of working secondhand sets and decided to display them for sale in the shop. If nothing else, it would get them out of the way and bring in a few dollars.

One of these was a secondhand Teac Televideo MV1440 which I switched on every day. Although I have an antenna distribution amplifier, there were too many of these sets and not enough antenna sockets for all of them, so some were connected to VCRs, some to the external antenna and some to indoor antennas. Reception from the external antenna is good but, as I am located in a valley, it is poor from an indoor antenna.

Unfortunately, it's not uncommon for someone to come in when I'm extremely busy and want to check out every – and I mean every – item on display. This bloke chose such a moment but wasn't particularly interested in any of the sets that were switched on and running. Instead, he wanted to see a 34cm NEC that was tucked on a top shelf, in an inconvenient corner and, of course, attached to only an indoor antenna. I couldn't persuade him that any of the others was a better buy; he was insistent that he should see this one work.

I explained, "Yes, it works very well but as it's only connected to an indoor antenna, there will be some ghosting".

The customer seemed very intent on this set so, after nearly killing myself, I climbed up through a precariously presented display, found the power lead and plugged it in. The picture was bright and sharp but obviously ghosting and I could see that the customer's eyes were glazing over and he had moved onto the Teac Televideo VCR which was playing tapes.

"Well?" I asked him, "do you want the NEC". "No", he said; "I don't want a TV set with ghosting". I tried to explain that the ghosting was only due to the antenna but it was pointless; he had completely lost interest and was now intent on the Teac.

Obviously, this bloke had the attention span of a gnat. I had to work fast. The Teac was easily accessible and I could swap an antenna lead with another set to demonstrate the off-air reception. Now this set had been in the window for months – for some reason it just hadn't sold. Not that I had worried too much; I figured that it would sell sooner or later.

Anyway, when I tried to demonstrate the off-air reception, the sound was OK but there was no picture. I

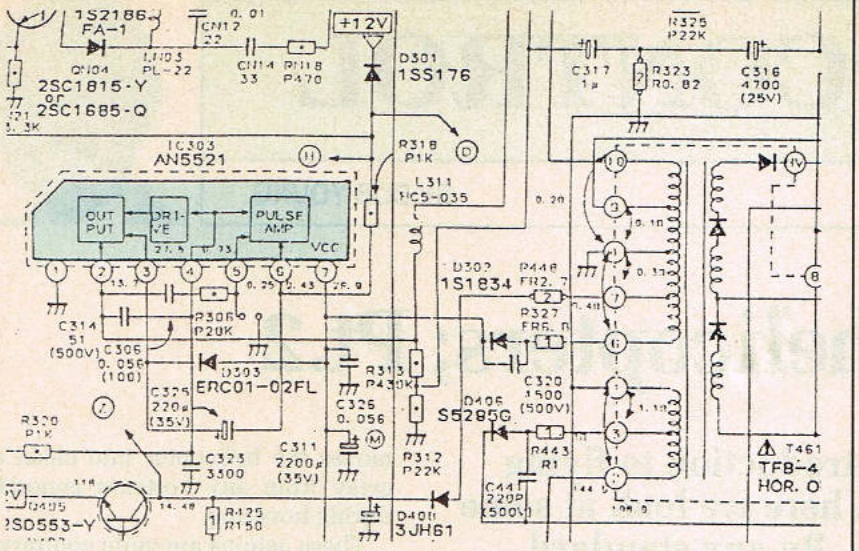


Fig.1: the circuitry around the vertical output IC (IC303) in the Toshiba 289X9M. Dry joints on this IC sometimes cause problems but, in this case, R327 had also burnt out.

didn't panic immediately as I felt sure that it was the AV switch incorporated in the BNC socket that was sticking but after fiddling with it for five minutes, the customer said he would call back later when it was working. "Yeah and pigs might fly," I thought.

Embarrassed and feeling somewhat foolish, I picked up the offending Televideo VCR and took it into the workshop. I really couldn't understand why it was working yesterday but not now but I suppose this is how everyone feels when something breaks down.

I connected a signal generator into the AV BNC socket and the set gave a very clear picture. This could only mean that the video was being lost between the video detector and this socket.

After removing the chassis, I followed the circuit back from the BNC socket switch until it disappeared underneath an electrolytic capacitor soldered onto the copper side of the board. This capacitor was anchored by a black substance, which on closer examination turned out to be the old brown corrosive glue we all like to curse. I removed the hardened black substance and located the track underneath it, which had corroded clean through. I then fitted a link across the gap and reassembled the TV set.

It now worked perfectly and was back in the showroom window with a good antenna and running on Channel 9 for the cricket. Now I wonder – will that bloke ever come back?

I thought it was just too bad that the glue had corroded right through the track in the last 12 hours – I deserve better!

The snowy Philips

Mr and Mrs Grogan own a Philips 28GR671 TV, which employs a G111-S chassis. They live in a nice spot on the side of a hill with magnificent views. However, because the VHF transmitters are on the other side of the hill, they were dependent on reception from a UHF translator.

Because they were apparently not getting good reception, especially on SBS and Ch.2, they decided to subscribe to cable TV. However, when this was installed they were still getting snowy pictures, which indicated a problem with the TV set itself.

In this case, the RF output of the set-top converter was connected to the antenna terminals of the TV set via a combiner (the external antenna fed the other input of the combiner). This meant that, as far as the TV set was concerned, the cable signals were just like an off-air UHF signal.

Because everything was on UHF, I was surprised to see that the higher channels – 7, 9 and 10 on Band V – were giving good reception; it was just the lower ones on Band IV that were snowy. I checked the antenna installation out and everything seemed OK. I then connected the antenna to a portable loan set I had with me and there was no problem with that.

At this stage, I decided to put the problem into the "too hard" basket and to take the set back to the workshop. At least, I would have time to think there and sort out this rather perplexing problem.

When I subsequently connected the set to my antenna, all the stations were perfect with no snow at all. Puzzled by this, I assumed that the set must have come good in the truck on the way back, and though I tried tapping, heating and cooling, I couldn't fault the reception on any channel. In the end, I could only take the set back to the Grogans and make some rather weak excuses.

When I finally got it back into its resting place (no mean feat, as it is a big and heavy set), I switched it on and was horrified to see that it was still snowy on the lower channel numbers. I just couldn't believe it – what was I overlooking? It just didn't make sense. I spent half an hour rechecking everything before admitting defeat and taking it back to the workshop where, of course, the reception was still perfect.

Eventually, I realised that it was possibly an AGC fault. However, when I adjusted the RF AGC control (VR-301212), I found that it was already set to its optimal position and could take the set from snow to signal overload as expected.

Next I tried fitting a 6dB attenuator but this made no difference on my powerful antenna distribution system. However, when I got to 18dB attenuation, I finally managed to recreate the situation the Grogans were experiencing – the higher channels were better than the lower ones. I reached in to have another go at the AGC control when my hand brushed against the tuner and I noticed the snow momentarily clear up.

Well, that was it. There was a bad connection between the tuner's metal case and the main metal chassis frame. The problem was not that the tuner wasn't earthed, rather that it wasn't supplying a ground rail for other circuits in the small signal, IF and AGC areas. Anyway, that fixed up the fault even when it was back at the Grogans' home. **SC**

RADIO CONTROL

BY BOB YOUNG

Model R/C helicopters; Pt.2

Following last month's introduction to flying radio control helicopters, here we look at some of the mechanical aspects. By any standard, model helicopters are extremely complicated mechanisms.

In some respects, model helicopters are more complex than real helicopters. They are more difficult to fly than other R/C aircraft too but all of this is part of the attraction; helicopters are a lot of fun.

Flying one represents a complete departure from the traditional aspects of R/C model aircraft. In some respects it is almost easier to have no previous R/C aircraft experience when fronting up to these exotic little machines. This at least saves you from having to unlearn heavily conditioned reflexes built up over many years of fixed-wing flying.

Last month I mentioned the problem of helicopter emergency procedures being the exact opposite to those of fixed wing aircraft; in a fixed wing aircraft we instinctively chop the throttle and pull up elevator when things suddenly go pear-shaped. In a helicopter this would be catastrophic; the correct course is usually to apply full throttle and full forward cyclic pitch.

The latter course results in an increase in altitude from the increased power, collective pitch and translational lift component introduced by increasing the forward speed. It also moves the helicopter into clean air, away from any vortexes generated during hovering.

These actions are quite contrary to fixed-wing procedure. Add to this the facts that helicopters obey a more complex set of aerodynamic laws and that building a model helicopter is more akin to model engineering than aircraft modelling in the traditional sense. It then becomes obvious that helicopter fliers live in a dramatically different world to the conventional aeromodeller.

Fig.1 is an isometric view of the internals of a small modern helicopter, the Robbe Schluter Futura Super Sport .60. The ".60" designation, by the way, refers to the capacity of engine required for the size of the aircraft – in this case, 0.60 cubic inch capacity.

The Futura Super Sport .60 is an interesting design featuring some novel mechanical approaches to long-

A typical example of today's radio controlled model helicopters is the Robbe Schluter Moskito Expert. Learning to fly an aircraft like this will take the average person many, many hours and probably involve a fair number of "hard landings".

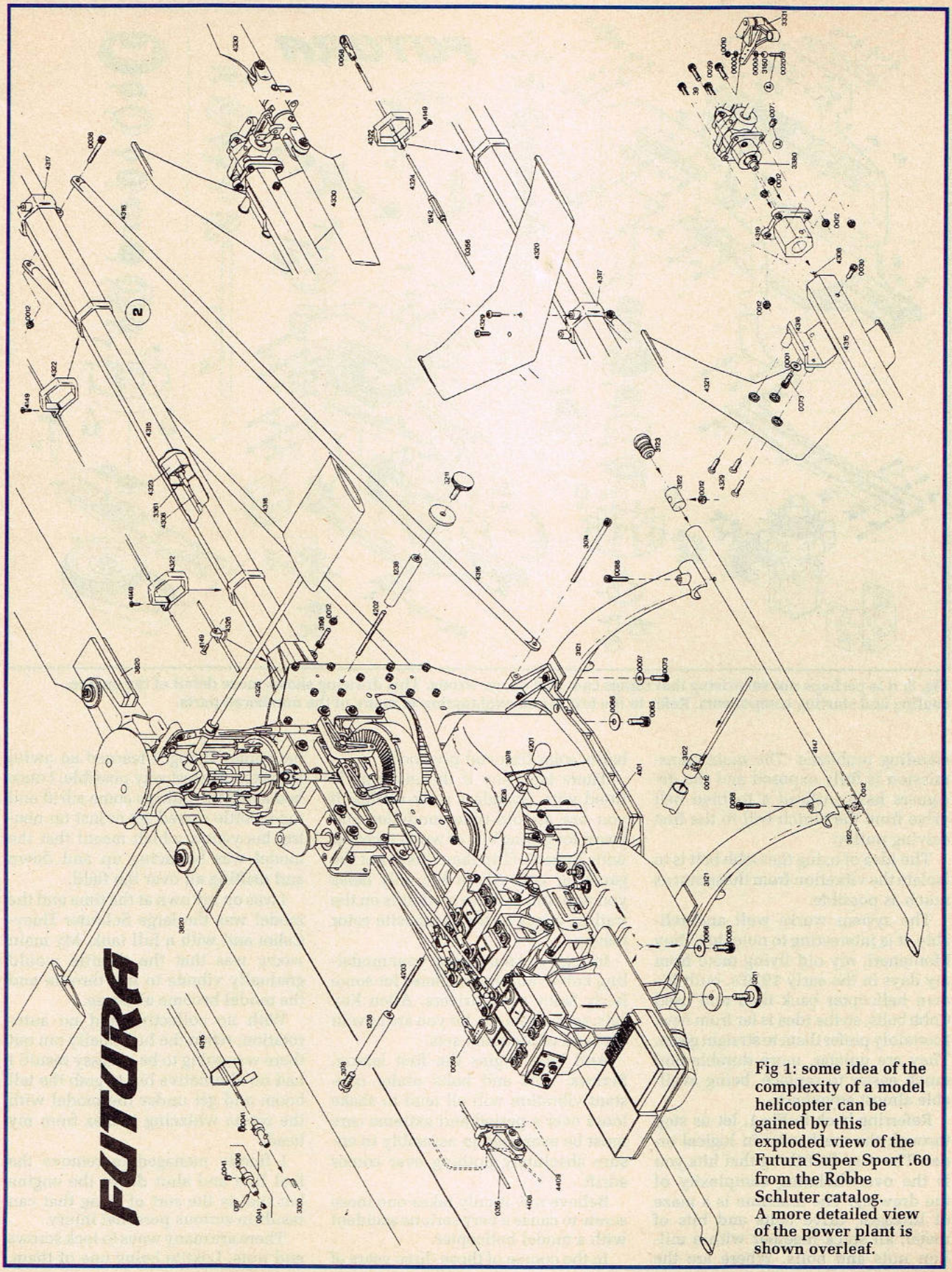


Fig 1: some idea of the complexity of a model helicopter can be gained by this exploded view of the Futura Super Sport .60 from the Robbe Schluter catalog. A more detailed view of the power plant is shown overleaf.

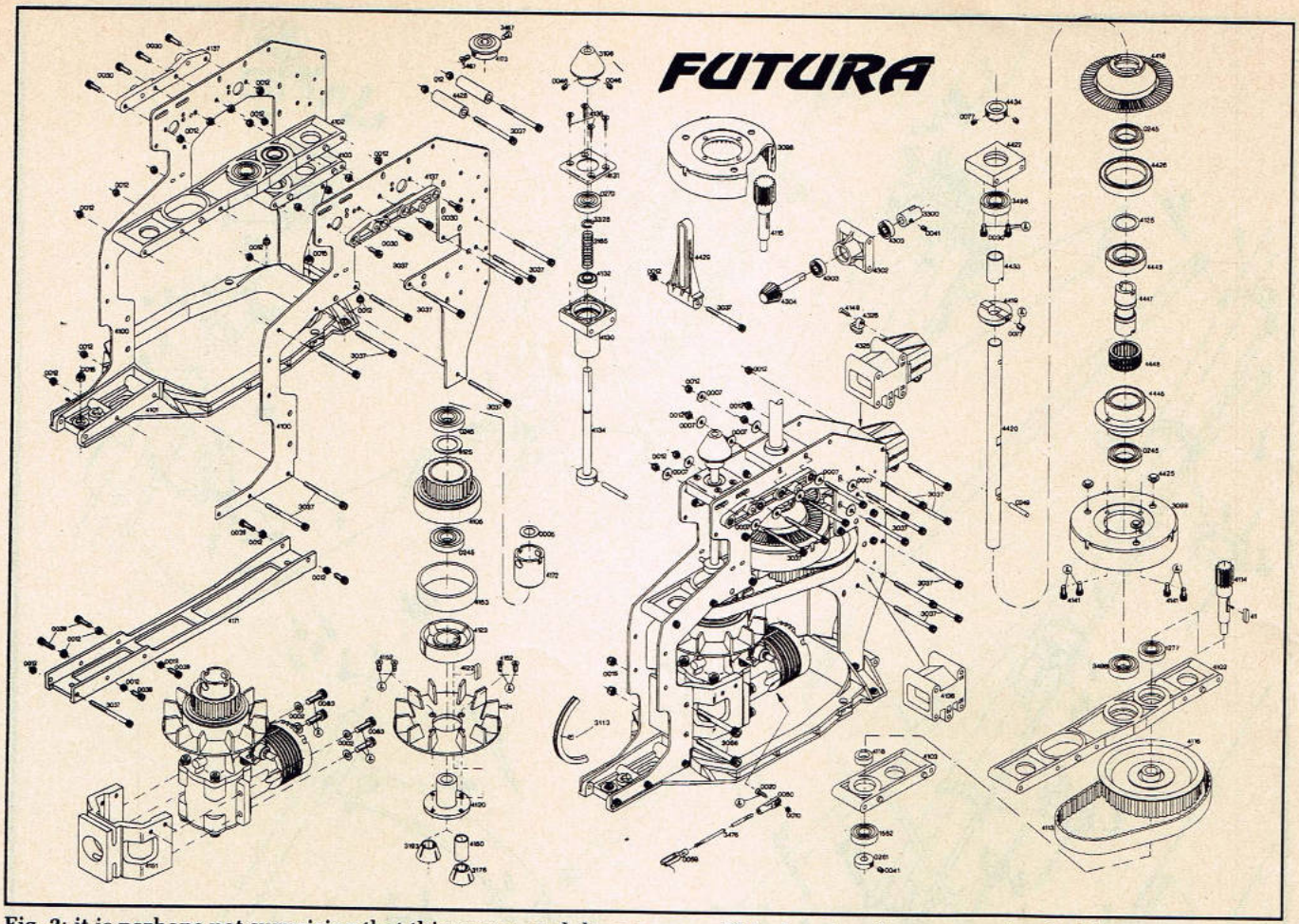


Fig. 2: it is perhaps not surprising that things can, and do, go wrong. This drawing shows more detail of the engine, cooling and starting components. Refer to the text for an explanation of many of the numbered parts.

standing problems. The main transmission is fully exposed and the designers have utilised a toothed belt drive from the clutch bell to the first driving pulley.

The idea of using the Cobb belt is to isolate the vibration from the motor as much as possible.

The system works well and reliably. It is interesting to note that Tony Montanari, my old flying mate from my days in the early 1970's, built his own helicopter back then and used Cobb belts, so the idea is far from new. I certainly prefer them to straight gears. They are quieter, more durable and much easier to replace, being available almost anywhere.

Referring back to Fig.1, let us step through the mechanics in logical order. The very first thing that hits you is the overwhelming complexity of the drawing. The machine is a maze of linkages, drive belts and bits of metal, all stuck together with a million nuts and bolts. Where are the balsa, solar film and plywood?

There isn't any if the machine is fitted with fibreglass rotor blades. If you are an old-time modeller and yearn for gluing bits of wood together with Tarzan's Grip then this is not the game for you. About the only balsa you will find in these models is on the trailing edges of the composite rotor blades.

Instead you must swap your modelling knives and razor planes for some fairly fancy screwdrivers, Allen Key sets, socket sets etc, for you are now in the land of Meccano sets.

And here begins the first lesson. Screws, nuts and bolts under constant vibration will all tend to shake loose over a period and extreme care must be exercised in assembly to ensure absolutely nothing ever comes adrift.

Believe me, it only takes one loose screw to cause a very serious accident with a model helicopter.

In the course of those three years of helicopter flying, I learned an awful lot in the hardest way possible. I once had a throttle linkage come adrift and the throttle stayed set at just on neutral buoyancy, which meant that the model was bouncing up and down and drifting all over the field.

I was on my own at the time and the model was the large Schluter Huey-Cobra and with a full tank. My main worry was that the throttle would gradually vibrate to full throttle and the model become airborne.

With no collective and no autorotation, when the fuel finally ran out there was going to be a messy result! I had no alternative but to grab the tail boom and get under the model with the rotors whizzing inches from my head.

I finally managed to remove the fuel line and shut down the engine but that is the sort of thing that can result in serious personal injury.

There are many ways to lock screws and nuts, Loktite being one of them.

Loktite will let go under fairly intense heat but on the field it can be awkward to make adjustments with Loktited screws and nuts. My favourite method is to use contact cement. It peels off readily and can be dissolved with methylated spirits if required. But it holds those nuts and bolts under all conditions.

The opening photograph shows a complete Robbe Schluter Moskito Expert as flown by Melbourne helicopter whiz, Nick Csabafy. This helicopter uses the more traditional fully enclosed reduction gearbox, with a reduction of around 1:9 or 1:10. Amongst the millions of problems facing the model helicopter pioneers, gearbox reduction ratios were one of the big ones.

Taking their lead from full-size helicopters, they were running the main rotor too slowly. They had forgotten the problems introduced by scale effect. Once again Reynolds numbers reared their ugly heads. Over and over in model development we encounter this problem.

Once rotor speeds were increased, things started to move in the right direction. Thus reduction ratios are a very important factor in model helicopter design. Reduction ratios of 1:10 result in a main rotor speed of approximately 1,000 RPM.

Referring to Fig.2 we can see that the Futura is built around a pair of cleverly designed "U" shaped plates (4100). These provide the mounting for the engine, transmission, main rotor bearing blocks (4102, 4103), tail boom (4135) and servo mounts. In short, everything hangs off these plates.

The fuselage for this model is similar to the Moskito shown in Photo 1. The beauty of this type of fuselage shell is that all exhaust gases are blown clear of the motor. Nick has even fitted a tuned pipe exhaust to his Moskito which pushes the exhaust gases even further away from the carburettor. Now the point here is that running a motor without a propeller inside a completely enclosed fuselage gives rise to several very serious problems.

First and most obvious is that without the stream of air provided by the propeller, the motor is going to run very hot. Thus helicopters use a cooling fan (item 4124) fitted inside a streamlined housing to provide adequate cooling. While on this point, the correct type of fuel is also a very important issue in helicopters. Incorrect oil types and mix ratios will result in the engine overheating and plenty of auto-rotation and engine overhaul practice.

Secondly, it is most important to ensure that the exhaust gases are pumped outside the fuselage and that they are not sucked back in during extended hover in still air. These gases are very hot and depleted of oxygen. As the carburettor is gulping great quantities of air it can draw in these hot, oxygen-depleted gases, further overheating the engine and degrading the engine performance markedly. Watch for exhaust leaks after each flight and for telltale signs of the exhaust gases being drawn back into the fuselage during operation.

This was the most serious problem we faced with the Huey Cobras. The engines drowned in their own exhaust effluent. Before we modified the cooling arrangement the motors ran hot and sagged badly, particularly in hover. Large cooling gills cut in the fuselage sides and covered with fine mesh plus a ram air-scoop from the dummy jet intake cured the problem completely. The airflows around hovering helicopters are very complex and can do some very strange things, so stay alert to these types of problem, particularly in still air.

Attached to the cooling fan is the main clutch (4123) and the clutch housing (4105) is integral with the tooth belt pinion. In operation, the clutch engages when the engine RPM reach a pre-determined level. This al-

It's not all fun and games: model R/C helicopters have practical business uses too! Here an X-cell .60, built and flown by Bob Haines from Brisbane, carries aloft a specially mounted video camera for aerial filming. Still cameras can also be mounted in this way – they're especially popular with real estate agents. Sure beats $1000 an hour or more to hire a full size helicopter!

lows the main rotor drive to be disengaged for starting and to ease the load on the engine when in idle. The motors are started with an electric starter and a boss is usually provided to allow ready access for the starter cone.

The belt drives the first reduction gear, a Nylon-toothed pulley (3099) which is fitted with a second reduction pinion (4114). This drives the second reduction gear (3099), an internal straight cut gear. From here the drive goes straight to the main rotor via an elaborate set of bearings, the most important of which is item 4448, the Sprague clutch. This is a special type of bearing that free-wheels in one direction and locks up in the other direction.

Its function is to allow the main rotor to be driven from the motor but when the motor stops the main rotor can free-wheel to allow auto-rotative decent. This is the heart of the modern helicopter.

I once fitted one of these bearings to an early Kavan Jet-Ranger that was not designed for auto-rotation. However, I thought I would get smart and separate the collective and throttle controls at the same time, in order to make practicing auto-rotations easier. What a mistake! I got excited on the first flight and reduced the pitch without reducing the throttle.

The rotor RPM shot up and I could literally see the blades stretching in front of my eyes. I thought the blades were going to come off. We had all heard horror story of blades coming off and I thought this was it. I chopped the throttle and the Sprague clutch disengaged and the blades kept flying around at the same speed. It seemed to take forever for those blades to slow down but at least they stayed on the helicopter.

The most amazing thing however was that all I had to do to stop the blades was gradually increase the pitch. I could have done that without increasing the engine RPM and re-engaging the main clutch. Instead I just stood there mesmerised by the whirling rotor blades. It was a classic case of inadequate training in emergency procedures. You just cannot approach any aviation-related activity with a half-baked mental attitude.

You are in boots and all, right from the moment that aircraft leaves the ground, because you only get one go and it has to be right the first time. I went straight back to the factory and re-coupled the collective and throttle servos. All went well after that.

Item 4418 is the bevel gear drive for the tail rotor. The tail rotor is fitted with a pitch control mechanism and provides the anti-torque stabilisation as well as the yaw control. Because the motor is driving the main rotor in one direction, the fuselage will attempt to rotate in the opposite direction.

The tail rotor prevents this from occurring, however it does introduce a complication. There is a reaction set up that pushes the helicopter sideways and this must be offset by some tilt in the main rotor disc. We will look at this next month in the flying section.

The main rotor assembly is made up of the two main blades and two smaller paddles. The action of the paddles is quite complex but essentially they are the equivalent of trim tabs on fixed-wing aircraft. The cyclic pitch controls are fed into the paddles and the paddles move the main blades.

There is an added complication here in the form of gyroscopic precession. This means that any control variation must be introduced 90° out of phase with the main rotor location. The action occurs 90° later (in the direction of the rotor rotation).

Thus to raise the rear of the rotor disc to move the helicopter forward, the correct blade must be increased in pitch on the forward (rotational) side of the helicopter – see Fig.3

Is it any wonder that the early pioneers had so much trouble getting these things to work?

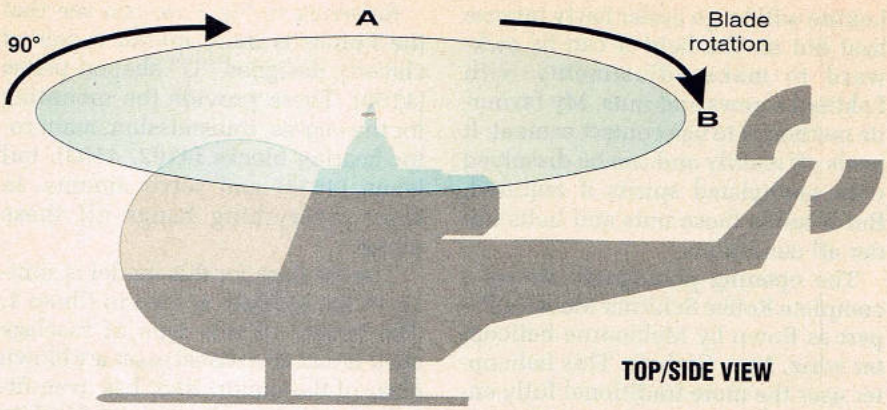


Fig. 3: gyroscopic precession means that an action expected to occur at one point will actually occur about 90 degrees of blade rotation later. Thus to raise the rear of the helicopter (the action at point B) the control must be exerted at point A, which would normally be expected to give forward/aft control.

They are a brilliant piece of engineering and are now commonplace and quite manageable, even for tyro modellers. The human mind never ceases to amaze me. In technology nothing seems impossible. Sadly in sociology, nothing seems possible!

The swash plate is the rotor head control centre. This plate is tilted for cyclic control and raised and lowered for collective pitch control. This is the plate in Fig.1 at the bottom of the maze of linkages just below the rotor and paddle junction.

A single screw is used to anchor the main rotor blades in the modern helicopter. This allows self-alignment of the blades plus it largely eliminates the danger of a blade splitting between multiple bolt holes, especially if the tip strikes the ground. This was a major cause of blades flying off in the early days.

The rest of the helicopter is largely made up of brackets for mounting the servos, receiver, battery pack, switch harness, gyro and fuel tank. Anchor points are also provided for mounting the fuselage shell. All in all, it is a very impressive package.

The second photograph shows an interesting twist: a helicopter fitted with a video camera. The model is an X-cell heli by Bob Haines in Brisbane (photo courtesy Max Tandy). Next month we will look at flying one of these little devils. **SC**

Acknowledgments:
My thanks to: (1) Nick Csabafy, N. C. Helicopter Services, Vic. (2) Max Tandy Helicopters, Qld. (3) Drawings; Robbe Schluter, Germany.

Silicon Chip Bookshop

SUBSCRIBE AND GET 10% OFF
SEE PAGE 33

Guide to Satellite TV*

Installation, Reception & Repair. By Derek J. Stephenson. First published 1991, reprinted 1997 (4th edition).

This is a practical guide on the installation and servicing of satellite television equipment, including antenna installation and alignment. The cover-age of the subject is extensive, without excessive theory or mathematics. 383 pages, in hard cover at $60.00.

Understanding Telephone Electronics*

By Stephen J. Bigelow. Third edition published 1997 by Butterworth-Heinemann.

This is a very useful text for anyone wanting to become familiar with the basics of telephone technology. The 10 chapters explore telephone fundamentals, speech signal processing, telephone line interfacing, tone and pulse generation, ringers, digital transmission techniques (modems & fax machines) and much more. Ideal for students. 367 pages, in soft cover at $55.00.

The Art of Linear Electronics*

By John Linsley Hood. Published 1993.

This is a practical handbook from one of the world's most prolific audio designers, with many of his designs having been published in English technical magazines over the years. A great many practical circuits are featured – a must for anyone interested in audio design. 336 pages, in paperback at $80.00.

Digital Audio & Compact Disc Technology*

Produced by the Sony Service Centre (Europe). 3rd edition, published 1995.

This is the best book on compact disc technology that we have ever come across. It covers digital audio in depth, including PCM adapters, the Video8 PCM format and R-DAT. If you want to understand digital audio, you need this reference book. 305 pages, in paperback at $90.00.

Servicing Personal Computers*

By Michael Tooley. First published 1985. 4th edition 1994.

Computers are prone to failure from a number of common causes & some that are not so common. This book sets out the principles & practice of computer servicing (including disc drives, printers & monitors), describes some of the latest software diagnostic routines & includes program listings. 387 pages in hard cover at $90.00.

Radio Frequency Transistors*

Principles & Practical Applications. By Norm Dye & Helge Granberg. Published 1993.

This book strips away the mysteries of RF circuit design. Written by two Motorola engineers, it looks at RF transistor fundamentals before moving on to specific design examples; eg, amplifiers, oscillators and pulsed power systems. Also included are chapters on filtering, impedance matching & CAD. 235 pages, in hard cover at $105.00.

Audio Electronics*

By John Linsley Hood. Fist published 1995. Second edition 1999.

This book is for anyone involved in designing, adapting and using analog and digital audio equipment. It covers tape recording, tuners and radio receivers, preamplifiers, voltage amplifiers, audio power amplifiers, compact disc technology and digital audio, test and measurement, loudspeaker crossover systems, power supplies and noise reduction systems. 375 pages in soft cover at $79.00.

Guide to TV & Video Technology*

By Eugene Trundle. First published 1988. Second edition 1996.

Eugene Trundle has written for many years in *Television* magazine and his latest book is right up date on TV and video technology. Includes both theory and practical servicing information. Ideal for students and technicians. 382 pages, in paperback, at $55.00.

Your Name_____
PLEASE PRINT

Address_____

_____ Postcode_____

Daytime Phone No._____ Total Price $A _____

☐ Cheque/Money Order ☐ Bankcard ☐ Visa Card ☐ MasterCard

Card No. ____ ____ ____ ____

Signature_____ Card expiry date____/____

Return to: Silicon Chip Publications, PO Box 139, Collaroy NSW, Australia 2097. Or call (02) 9979 5644 & quote your credit card details; or fax to (02) 9979 6503.

	Title	Price
☐	Guide to Satellite TV	$60.00
☐	Understanding Telephone Electronics	$55.00
☐	The Art Of Linear Electronics	$80.00
☐	Digital Audio & Compact Disc Technology	$90.00
☐	Servicing Personal Computers	$90.00
☐	Radio Frequency Transistors	$105.00
☐	Audio Electronics	$79.00
☐	Guide to TV & Video Technology	$55.00
	Postage: add $5.00 per book. Orders over $100 are post free within Australia. NZ add $10.00 per book; elsewhere add $15 per book.	
	TOTAL $A	

***All titles subject to availability. Prices valid until 28th February, 1999**

By RICK WALTERS

Build A Digital Capacitance Meter

Got a junk box with a stack of capacitors with the values rubbed off? Maybe you are building a filter & need to match some capacitors closely. Or maybe you just can't read the capacitor labels. This neat little Capacitance Meter will soon let you check their values. It measures capacitors from a few picofarads up to 2µF.

Every multimeter will read resistance values but few will read capacitance or if they do, they don't read a wide enough range. This unit can be built in several forms. It can be a self-contained unit with its own digital display or it can be built as a capacitance adaptor to plug into your digital multimeter. And you can run it from batteries or an AC or DC plugpack.

Our preferred option is to build it as a self-contained instrument running from a DC plugpack. Batteries are OK but we prefer to do without them wherever possible. If you only use the item on infrequent occasions, the batteries always seem to be flat.

Our new Digital Capacitance Meter is a simple instrument with no-frills operation. It is housed in a small plastic utility box with an LCD panel meter and a 3-position switch labelled pF, nF and µF. There are two terminal posts for connection of the capacitor to be checked and no On/Off switch. To turn it on, you plug in your 12V plugpack.

The unit will measure capacitance values from just a few picofarads up to 2µF. Its accuracy depends on calibration but it should be within ±2%.

Theory of operation

The theory of operation of the capacitance meter is simple and is illustrated in Fig.1. We apply a square

Parts List

1 main PC board, code 04101991, 89 x 48mm
1 switch PC board, code 04101992, 44 x 30mm
1 plastic case, 130 x 68 x 41mm, Jaycar HB-6013 or equivalent
1 front panel label, 120 x 55mm
1 3-pole 4-position rotary switch
1 knob to suit switch, Jaycar HK-7020 or equivalent
1 power input socket, 2.1mm x 5.5mm, Jaycar PS-0522 or equivalent
1 red binding post
1 black binding post
2 3mm x 10mm countersunk head screws
4 3mm nut
2 3mm star washer
1 20kΩ multi-turn top adjust trimpot (VR1)
1 2kΩ multi-turn top adjust trimpot (VR2)
1 100kΩ vertical trimpot (VR3)

Semiconductors
1 74HC132 quad NAND Schmitt trigger (IC1)
1 74HC86 quad exclusive-OR gate (IC2)
1 TL071, FET-input op amp (IC3)
1 2N2222, 2N2222A NPN transistor (Q1)
1 78L05 5V 100mA regulator (REG1)
2 1N914 signal diodes (D1,D2)

Capacitors
4 100µF 25VW PC electrolytic
1 1µF 25VW PC electrolytic
1 0.1µF MKT polyester
2 .01µF MKT polyester
1 12pF NPO ceramic

Resistors (0.25W, 1%)

1 8.2MΩ	1 15kΩ
1 820kΩ	1 10kΩ
2 220kΩ	1 8.2kΩ
1 20kΩ	1 1.5kΩ

Panel Meter Option
1 panel meter, Jaycar QP5550 or equivalent
1 TL071 FET-input op amp (IC4)
1 0.1µF MKT polyester capacitor

Resistors (0.25W, 1%)

1 1.5MΩ	2 20kΩ
3 100kΩ	4 10kΩ
1 39kΩ	1 1kΩ

1 100kΩ vertical trimpot (VR4)

Battery Option
1 SPST toggle switch (S2)
1 9V battery (216)
1 battery clip to suit

Plugpack Option
1 12VDC or 9VAC plugpack
1 panel mounting socket to suit plugpack
1 78L05 5V 100mA regulator (REG2)
1 3.9V 400mW/500mW zener diode (ZD1)
1 1N4004 1A power diode (D3)
1 470µF 25VW PC electrolytic capacitor
1 2.2kΩ resistor (0.25W, 1%)

Miscellaneous
Hookup wire, machine screws & nuts, solder.

wave to one input of an exclusive-OR gate and feed the same square wave through a resistor to charge the capacitor we are measuring. The voltage on the capacitor is fed to the other input of the XOR gate. While the capacitor's voltage is below the input switching threshold the output of the gate will be high (+5V). An XOR gate's output is low when both inputs are the same (low or high) and high when they differ.

The larger the value of the capacitor the longer it will take to reach the threshold and consequently the higher the duty cycle of the output pulse waveform (ie, wide pulses). Putting it another way, if the capacitor is small, it won't take long for it to charge and so the resulting pulses will be very narrow. This pulse waveform is integrated (filtered) and fed to a voltmeter. The circuit time constants are arranged to make the voltage reading directly proportional to capacitance.

How it works

Of course, like all theory, the practical realisation is a lot more complicated. The circuit of the Capacitance Meter is shown in Fig.2 and you may find difficulty in seeing any resemblance between it and the simple circuit of Fig.1. Never fear; we will explain it all.

First, IC1a is a Schmitt trigger oscillator and it oscillates at a rate determined by the switched resistors and the .01µF capacitor. IC1a has an output frequency of 16kHz on the pF range, 160Hz on the nF range and 16Hz on the µF range. The (approximate) square wave output is buffered and inverted by gates IC2b, IC2c and IC2d which have their outputs wired in parallel. These outputs are fed directly to pins 9 and 12 of IC1 and through trimpot VR2 and the 15kΩ resistor to the capacitor we are measuring (CUT).

The XOR gate IC2a corresponds to the single XOR gate shown in Fig.1. Note that Q1, the transistor that discharges the capacitor at the end of each charge cycle, is a 2N2222. This has been specified instead of the more

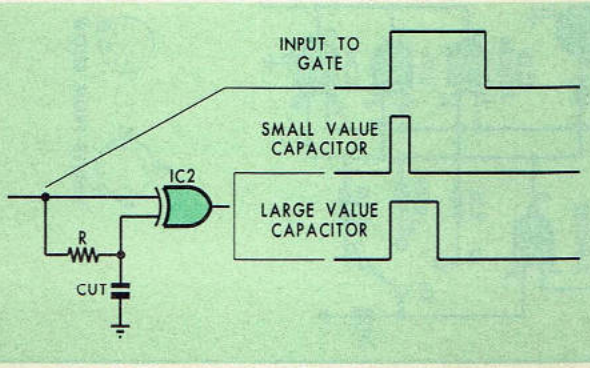


Fig.1: this is the principle of the Digital Capacitance Meter. A square wave is fed to an XOR gate and the time delay in charging the capacitor produces a pulse waveform with its duty cycle proportional to the capacitance.

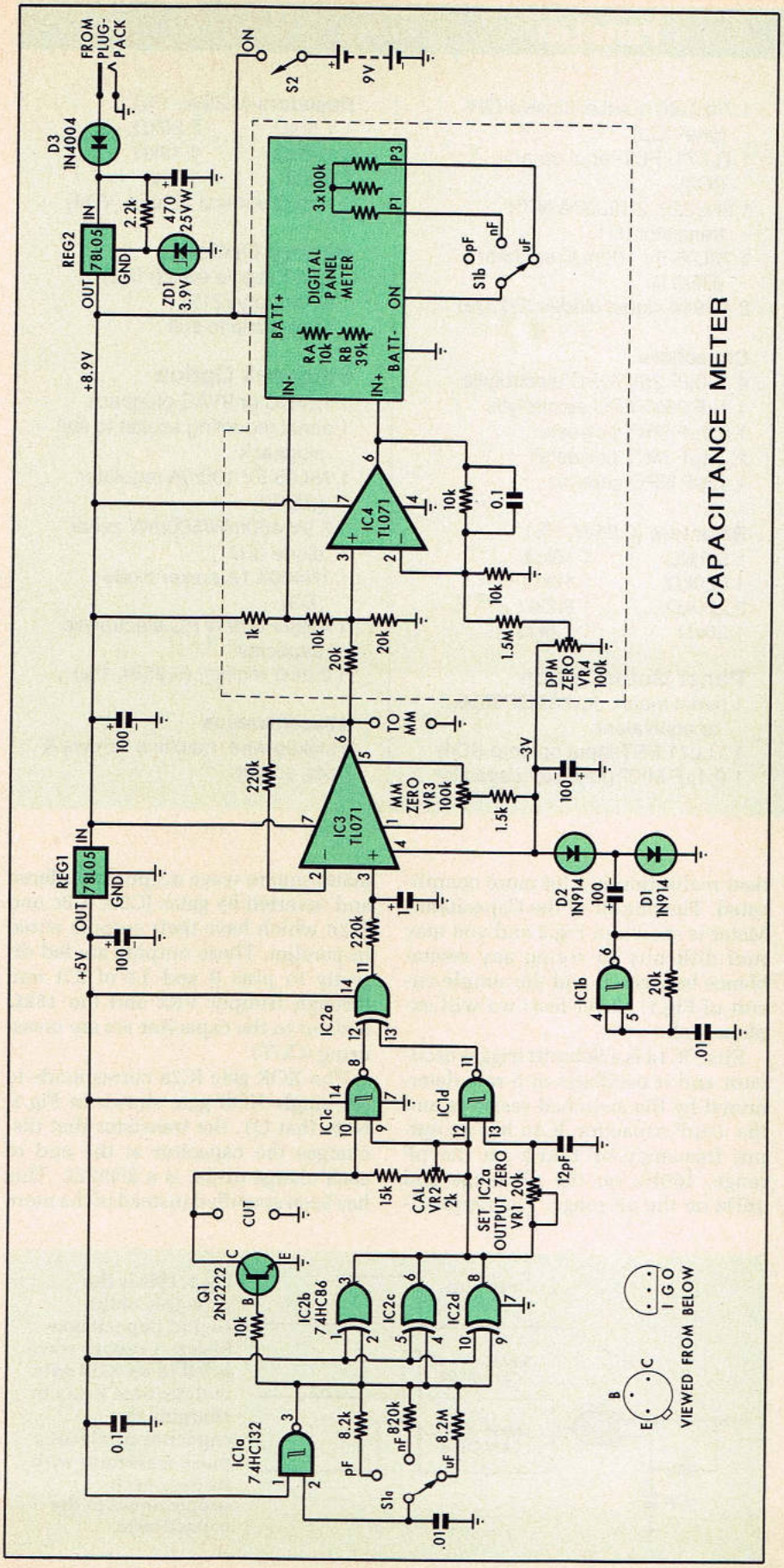


Fig.2: this circuit can be built as a capacitance adaptor for a digital multimeter or as a self-contained instrument with its own LCD panel meter. It can be powered from a 9V battery or a DC plugpack, in which case the circuit involving REG2 is required.

common varieties such as BC547 or BC337, in order to get sufficiently fast switching times.

We use two of the Schmitt NAND gates of IC1 (74HC132) as the inputs to IC2a and this has been done to ensure that these inputs make very fast transitions between low and high and vice versa. Without the Schmitt trigger inputs, the XOR gate circuit of Fig.1 tends to have an indeterminate performance and the pulse output can be irregular.

The "capacitor under test" (CUT) charges via VR2 and the 15kΩ resistor and eventually the voltage at the input of IC1c (pin 10) will reach its switching threshold and pin 8 will go low. The capacitor is then discharged by transistor Q1 which is driven from the output of oscillator IC1a. The cycle then repeats, with the capacitor being charged again. The waveforms of Fig.3 illustrate the circuit operation.

This output pulse from IC2a is integrated by a 220kΩ resistor and a 1µF capacitor to provide a DC potential to the pin 3 input of op amp IC3, which is connected as a voltage follower. Trimpot VR3 is used to set the output at pin 6 to zero when the input is zero. This "offset adjust" is most important as an offset as low as 1mV is equivalent to a reading of 1pF on the most sensitive range.

Since the output of IC3 must be able to swing to zero, IC3 needs a negative supply rail and this is provided by IC1b which is connected as a 10kHz oscillator. Its square wave output is rectified by diodes D1 & D2 in a diode pump circuit. The resulting DC supply is about -3V.

Stray capacitance

Even with no external capacitor connected, the stray capacitance on the PC boards and the interconnecting-wiring will have to charge and discharge. This stray capacitance will thus be seen by the rest of the circuit

as a capacitor connected across the terminals. In effect, the stray capacitance will slightly slow the charging and discharging of the real capacitor under test.

To compensate for the stray capacitance, we've added a delay circuit to the pin 13 input of IC1d. The idea is to provide the same delay to IC1d as the stray capacitance causes to pin 10 of IC1c. Then both delays will cancel out. The delay circuit consists of a variable resistor (VR1) and a 12pF capacitor. VR1 can be adjusted so that with no external capacitor connected, the output of IC2a (pin 11) always stays low.

So far then we have described all the circuit you need if you plan to use your multimeter as the readout. The output of IC3 is can be fed directly to a digital multimeter and the reading in mV corresponds to the capacitance in pF, nF or µF. So if the reading is 0.471V and you are switched to the pF range, the capacitance is 471pF.

Digital panel meter

Unfortunately, we can't simply feed the output of IC3 to a digital panel meter to make the instrument self-contained. This is because currently available digital panel meters appear to take their reference from their 9V supply rail and so their input voltage needs to be offset with respect to the 0V line. That means that the panel meter usually needs a separate isolated 9V power supply which could be a big drawback.

Fortunately, John Clarke has figured out an elegant way to solve the problem.

As the negative input of the panel meter sits around 2.6-2.8V below the positive rail (say 6.3V for a 9V supply), we need an op amp to shift the output of IC3 from a 0-1.999V range to a 6.3-8.2999V range. IC4 does this for us.

The output of IC3 is attenuated by a factor of 4 by the two 20kΩ resistors and the 10kΩ resistor connected to pin 3 of IC4, while the gain of 2 is determined by the 10kΩ feedback resistors connected to pin 2. The 1.5MΩ resistor has a negligible effect.

Thus, the 0-1.999V variation at the output of IC3 is translated to a 1V swing at the input of the digital panel meter. Resistors R_A and R_B are chosen to be 10kΩ and 39kΩ respectively for the meter's attenuator, which gives it a full scale sensitivity of 1V for a display of 1999.

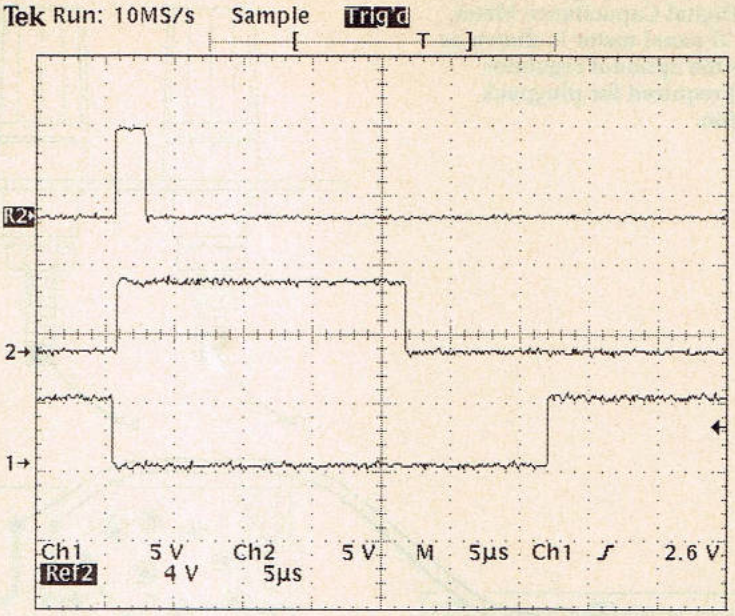


Fig.3: these waveforms show the operation of XOR gate IC2a. The bottom trace is the oscillator square wave while the top trace is the output with a small capacitor under test. The middle trace shows the output waveform for a larger capacitor. The output waveform is then integrated (filtered) to produce a DC voltage which is proportional to capacitance.

Trimpot VR4 sets the panel meter's readout to zero when the output of IC3 is zero. The decimal points on the display are all tied to the OFF connection through 100kΩ resistors. To illuminate a decimal point it is connected to the ON terminal by S1b, the second pole of the range switch.

Power supply

As already noted, the Capacitance Meter can be run from a 9V battery or from a DC or AC plugpack. If you plan to use a 9V battery, then you will have to fit an on/off switch instead of the plugpack socket. The 9V battery then feeds the panel meter, IC3 and IC4 directly and the 3-terminal 5V regulator REG1.

REG1 supplies CMOS gates IC1 and IC2. This is necessary to ensure that the meter's calibration does not vary with changing supply voltage.

If you plan to use a plugpack, more circuitry is required and this involves diode D3 and the additional 3-terminal regulator REG2.

Diode D3 ensures that a DC plugpack cannot cause any damage if it is connected with the wrong lead polarity. It then feeds REG2 which is jacked up by 3.9V zener diode ZD1 so that it delivers 8.9V to IC3, IC4 and the digital panel meter. REG2 also supplies REG1.

PC board assembly

The Digital Capacitance Meter uses two PC boards as well as the digital panel meter. The main PC board houses most of the circuitry while there is a smaller board for the range switch. Before starting assembly, check each PC board for defects such as shorted or broken copper tracks or undrilled holes. The diagram of Fig.4 shows the details of the two PC boards and all the interconnecting wiring.

You can begin by assembling the switch board which mounts just the 3-position switch and three resistors. Note that the specified switch is a 3-pole 4-position rotary type and it will have to be changed to give just three positions. This is done by removing the switch nut and washer, then prising up the flat washer which has a tongue on it. Move the tongue to the next anticlockwise hole and refit the washer and nut. It may sound complicated but once you are actually doing it, it will be straightforward. Make sure the switch provides three positions before you solder it to the board.

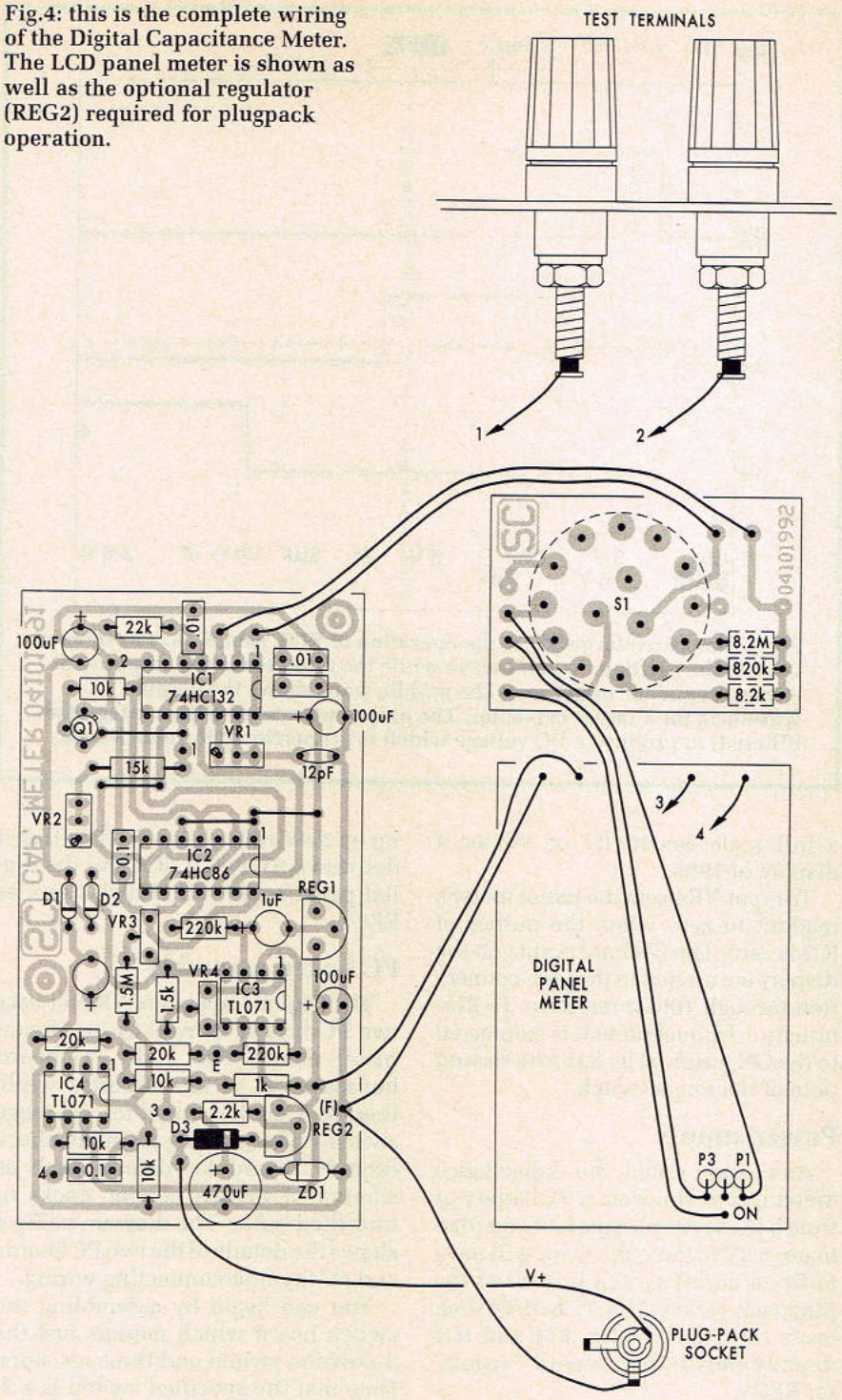


Fig.4: this is the complete wiring of the Digital Capacitance Meter. The LCD panel meter is shown as well as the optional regulator (REG2) required for plugpack operation.

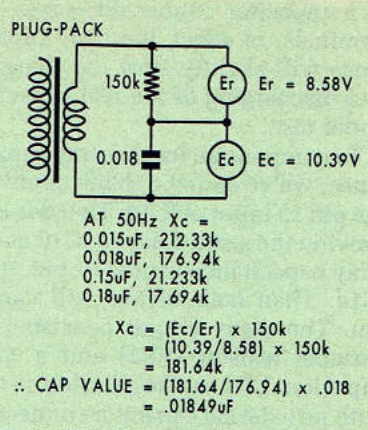


Fig.5: this diagram shows the connections and formulas to be used when calculating a capacitor's value for the calibration method. The digital multimeter used is assumed to have a typical accuracy of 2%.

Next, fit and solder the links, resistors and diodes into the main board, then mount the trimpots, capacitors, 3-terminal regulators and transistor. By the way, the 78L05 regulators look like ordinary plastic TO-92 transistors because they have the same encapsulation. They don't work like transistors though, so don't confuse them with the TO-18 metal-encapsulated 2N2222 transistor.

Finally, mount the op amps and lastly, the two CMOS ICs.

Once the two PC boards are assembled, it is time to work on the plastic case which needs the cutout for the LCD panel meter and the other holes drilled. The specified panel meter comes with a bezel surround so you don't need to be ultra-neat when making the cutout for it.

It is easier to drill all the holes in the plastic case and check that everything fits before wiring the units together. If you don't intend to use the LCD panel meter you may be able to use a slightly smaller case.

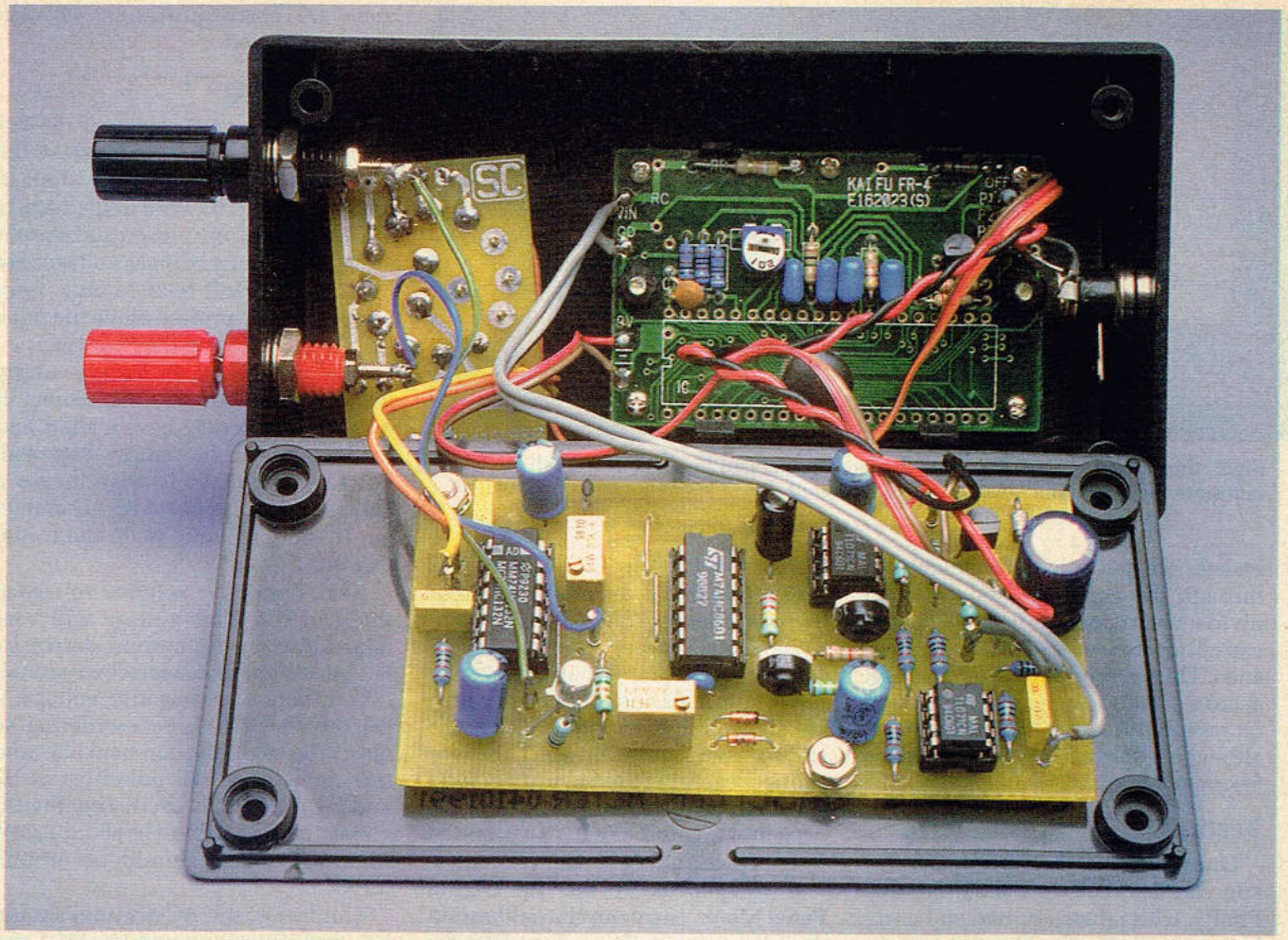
Once everything fits OK, wire the boards together following Fig.4 carefully. Make the leads long enough to be able to test the unit on the bench but not too long or they will be a nuisance when assembling the boards into the case.

When all the wiring is complete, check your work carefully and then apply power to the unit. The display should light and you should be able to make some measurements on capacitors although the readings probably won't be too close to the mark at this stage. It will be need to be calibrated.

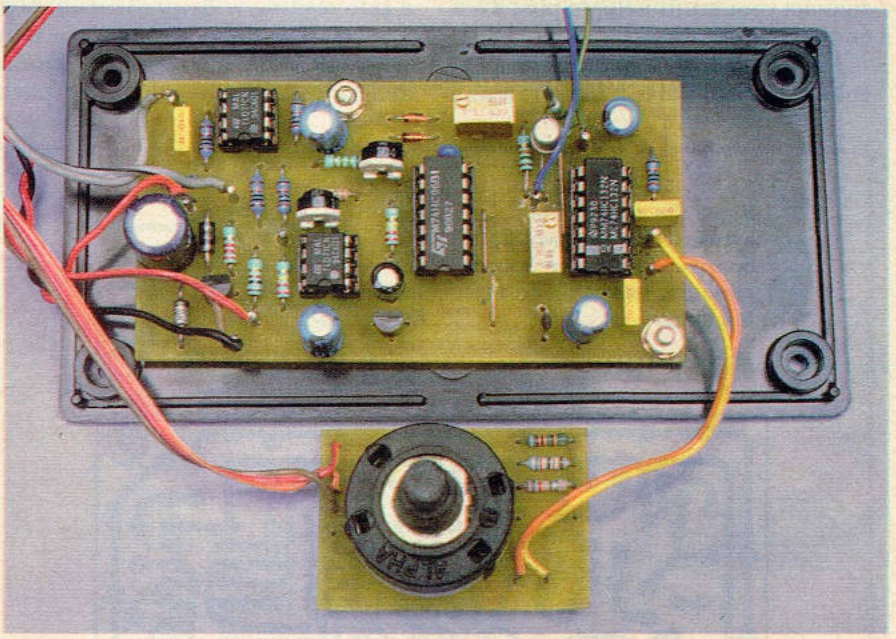
Calibration procedure

Now that you have a working capacitance meter how do you calibrate it? We have used 1% resistors on the range switch, so range-to-range accuracy should be within 1%. The basic accuracy of the instrument is set by the .01µF capacitor at the input of IC1a, along with VR2 and the associated 15kΩ resistor. The input thresholds of IC1 also affect the accuracy. These input thresholds can have a variation in excess of 1V from device to device, when using a 5V supply.

If we could get a precise .01µF capacitor we could specify an exact resistor value to replace the 15kΩ resis-



These two photos show how the PC boards and the LCD module all fit inside the plastic case. Note that the LCD module is optional – see text.



tor and trimpot VR2. Unfortunately, this would not solve the input threshold variation problem. As well, virtually all MKT capacitors have 10% tolerance (K), so we accept the supplied value of the capacitor and adjust the trimpot to calibrate the meter.

Having said all this, we still need an accurately known value of capacitor to carry out the calibration. One way is to obtain five or more of the same value (preferably .015µF or .018µF) and measure them all using the uncalibrated meter. Having measured them, add up the values and calculate the average and then use the capacitor which is closest to the average as the calibration unit. The problem with this method is that the whole batch could have its tolerance in the same direction.

If you have a digital multimeter there is a much better way. Power up an AC plugpack and set your DMM to read AC volts. Connect a 150kΩ resistor and a .015µF or .018µF capacitor in series across the AC output. Measure the AC voltage across each. We then use the formula shown in Fig.5 to calculate the capacitor value.

By measuring the voltage across the

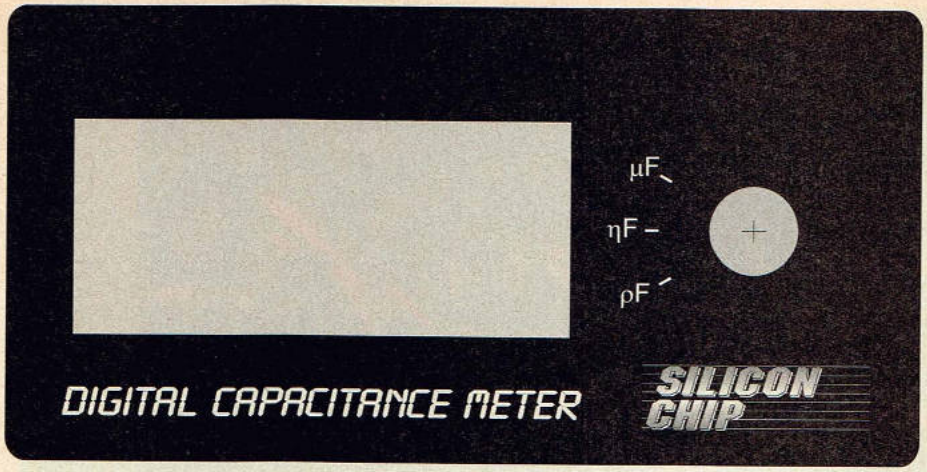


Fig.6: this actual size artwork for the front panel can be used as a drilling template for the switch and the display cutout.

resistor we can calculate the current through the capacitor and we then divide the capacitor voltage by the capacitor current to find its impedance. This method should give you an accuracy better than 2%, depending on your multimeter's AC performance, although it does assume that the mains frequency is exactly 50Hz.

Testing

Once you know the capacitor's value you can use it to do the calibration. Firstly, with power applied and nothing connected to the input terminals, connect your multimeter to pins E & F on the main PC board.

Adjust trimpot VR1 until the DC voltage at pin 11 of IC2 is a minimum (5-10mV depending on the setting of VR3). Note that it dips to a minimum then rises again. Then adjust VR3 until the meter reading is 0mV.

Connect the known capacitor to the input terminals and, on the appropriate range, adjust trimpot VR2 for the correct reading. If you get close but cannot reach the value, add an extra capacitor in parallel with the .01μF capacitor on pin 2 of IC1, as explained in the fault finding section.

If you elected to use the Digital Panel Meter, carry out the calibration described above, then adjust VR4 for a zero reading with no capacitor connected. This done, connect the standard capacitor across the terminals and adjust the trimpot on the panel meter's PC board until the correct reading is displayed.

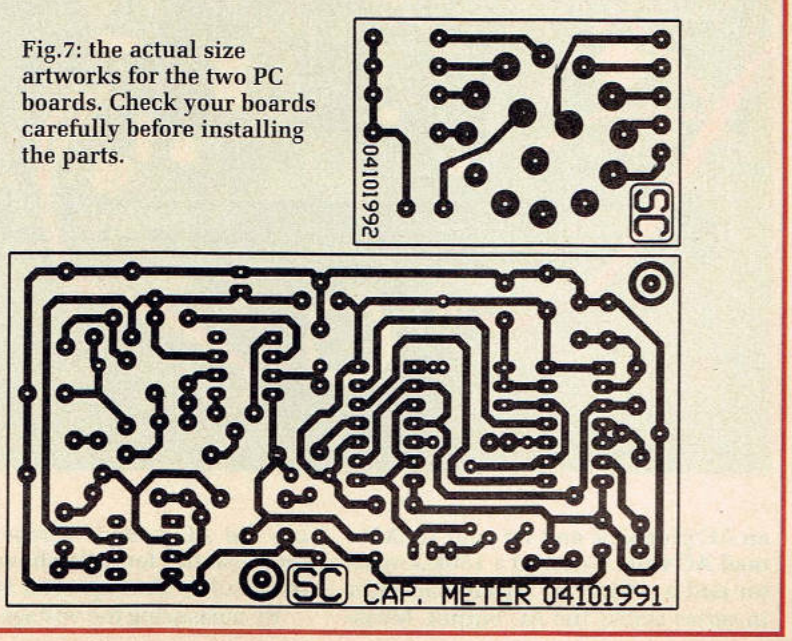


Fig.7: the actual size artworks for the two PC boards. Check your boards carefully before installing the parts.

Fault finding

The first check to make, if the circuit is not working, is to measure the DC voltages. Check that the input to REG1 is around 9V with either battery or plugpack supply. Its output should be 5V ±5%. If any of these voltages are missing, you will have to trace from where they are present along the track (or tracks) to where they vanish.

Obviously, if the 9V battery supply measures low or 0V, disconnect it quickly as you may have a short and the battery will be rapidly flattened. For this reason, it is wise to use a bench power supply with an ammeter, if you have one, to do the initial testing.

Next, check the negative voltage at pin 4 of IC3. This voltage will vary depending on the current drawn by IC4 but it should be somewhere around -3V. If there is no negative voltage, it is likely that IC1b is not oscillating, so check the soldering and tracks around this device and the polarities of D3 and D4. When it is oscillating the DC voltage at pin 6 should be about +2.3V. The AC voltage should be around 2.75V.

Similar DC and AC readings should be present at pins 3 and 12 of IC1 and pins 3, 6 & 8 of IC2. If you discover any voltages that are wildly different then you have found one (or all) of your faults.

If you cannot adjust trimpot VR2 to get the meter reading high enough then add a 470pF or .001μF capacitor in parallel with the .01μF capacitor at pin 2 of IC1. Provision has been made on the PC board for this additional capacitor. The value will depend on all the component tolerances, as previously explained.

Using it

Always start from the pF range and turn the switch clockwise if the readout indicates over-range.

The pF range covers from 1-1999pF; the nF range covers 0.1nF to 199.9nF (or if you prefer .0001μF to .1999μF); and the last range covers .001μF to 1.999μF. If you don't like nanofarads, and would like the middle range to display μF, disconnect the P1 decimal point wire from S1b. Of course, you will have to alter the label lettering to agree with this modification. SC

Remote Control Tester

Do you have problems with your infrared remote controls? Are their batteries dead or is it just that some of the buttons are not working? These and other questions involving remote controls can be readily answered with this handy tester.

By LEO SIMPSON

Everyone loves their remote controls, don't they? Whether they are used to mute those irritating adverts on TV or to fast-forward through adverts on taped programs, they are a real boon. And of course, they are used on a multitude of other appliances these days so we are really lost and frustrated when they don't work.

It is at these times that remote controls are instantly converted from items of utmost convenience to items of extreme frustration. How do you test them? You can't see the infrared beam that they are supposed to emit so you don't know if they are functioning or not. Then again, they might be functioning as far as some of the buttons are concerned and others might be dead. How do you find out?

On TV sets and other appliances which have an "acknowledge" LED, it is easy. Each time you press a button on the TV's remote control, the "acknowledge" LED flashes and you are instantly assured that all is well. But the "acknowledge" LED most likely doesn't work when other remote controls are pointed at it, so there's no help there. Some remotes also have a telltale red LED and thus they provide a good indication that they are working; most don't.

If you have a camcorder or video camera you can generally use it to check whether your remote is working. Just point it directly at the camera and you will see the telltale flashes in the viewfinder or monitor while a button is pressed. How so? Because most video cameras will respond to infrared light.

But while that is handy to know, it is not the most convenient setup if you are plagued with a pesky remote control that just does not want to behave and do what it's supposed to.

These thoughts were prompted by my recent bout of wrestling with a cantankerous remote control. It had been becoming increasingly unreli-

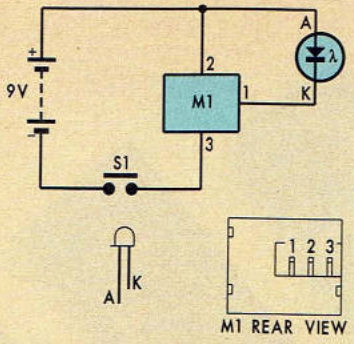


Fig.1: the circuit is based on an infrared detector module which drives the LED directly.

able over a period of a few months. The various users in the family responded by slapping it, pressing its buttons more fiercely and ultimately (shame) by saying unseemly words to it. None of these seemed to work as a cure.

Coincidentally, the remote control tester to be described arrived in the SILICON CHIP offices and I pounced on it. The idea is simple. It has a membrane key on the small case. You press it and then simultaneously press a button on your suspect remote. If it is working a LED on the remote tester flashes brightly, in time with the data modulated onto the infrared carrier. This is far more convenient than aiming the suspect remote at your TV.

The circuit of the remote control tester is shown in Fig.1. It consists simply of a 9V battery, a pushbutton switch, a LED and an infrared receiver module, M1. This infrared receiver module is contained in a compact tinplate case which houses a tiny PC board. This mounts an infrared detector diode, a surface mount preamplifier chip and number of other surface mount components. The module would normally be mounted behind a window in the front panel of a TV, VCR, CD player or whatever and would normally drive decoder circuitry.

In this case, we don't need any decoding. Instead, we want the tester to respond when any button on any IR remote control is pressed. That it does and it lights the LED on its front panel for as long as any button on the remote handpiece is pressed.

The module has inbuilt current limiting so it can drive the red LED directly, without resistors or any other components being required.

Building it

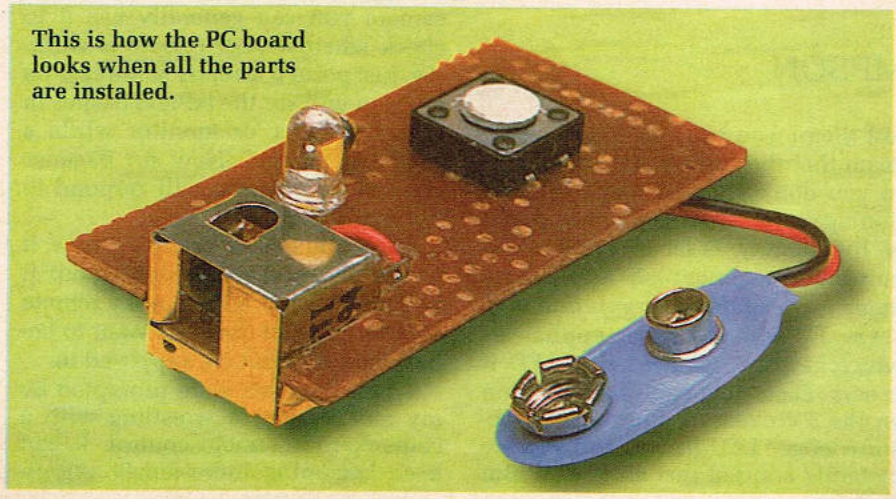
The circuit of Fig.1 is so simple that you really don't need a PC board to build it but one is available as part of a kit from Oatley Electronics. The kit comprises a surplus PC board, a 9V battery snap connector, a high brightness red LED, the infrared receiver chip, a membrane switch and a small plastic case measuring 123 x 36 x 23mm.

The PC board measures 60 x 30mm and has been designed for a more complex circuit so there are a lot of vacant component positions. The photos show how the PC board is wired and how it sits in the case. Fig.2 shows the wiring layout.

Putting it together will only take a few minutes but you do have to be careful with the polarity of the infrared detector, the LED and of course, the battery wires. The infrared detector module straddles one end of the PC board and lugs on the tinplate case are soldered to adjacent copper pads on the PC board.

The positive battery wire passes through a hole in the PC board and is then wired directly to pin 2 on the module. The LED is wired directly across pins 1 & 2 on the module as well. The negative lead from the battery is wired to the membrane switch and then to pin 3 on the module.

When you have the unit complete, connect the battery and press the membrane switch. The LED should flash once. Then if you aim an infrared remote control at it and press a button, the LED should flash for as long as the buttons are pressed. Remember though, you also need to keep the membrane switch on the tester pressed.

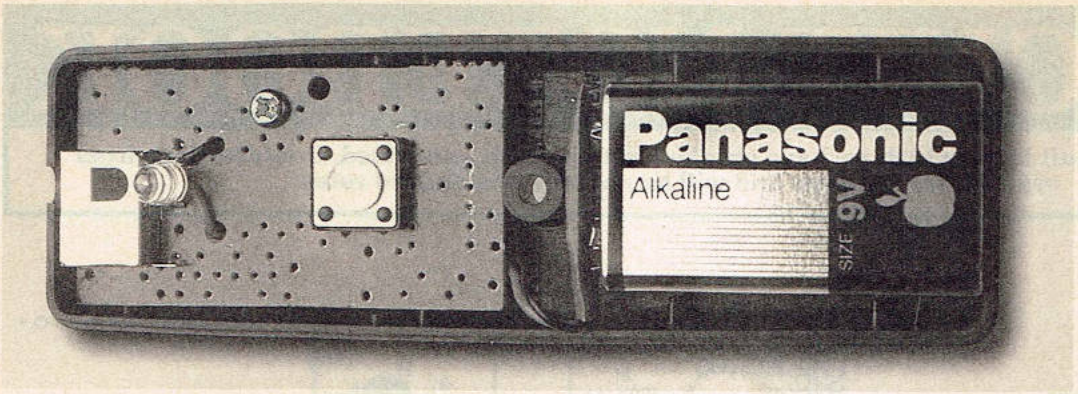


This is how the PC board looks when all the parts are installed.

Fixing remote controls

Well, once you have an infrared tester you will certainly be able to work out whether your remotes are working or not and whether some buttons are defective. But it is entirely another matter to fix them.

Let me tell you the story of the remote control that started this story. Well, the tester indicated that the remote was indeed malfunctioning and the TV was OK. But where was the fault because one or two of the but-



The PC board assembly sits at the top end of the case, with the battery occupying the other end. Take care to ensure correct battery polarity – the negative lead goes to the switch.

tons would work some of the time?

The first step was to check the batteries, two AA cells being used in this case. They were around 1.4V each and although not fresh out of the carton, they certainly should have been good enough to run the circuit. Most remotes will run quite happily with cells that are down to 1.2V and some will work with a lot less.

Mind you, the batteries are often not the problem but corrosion of the battery terminals can be quite obvious when you take the trouble to look. This can be most easily cleaned off using a Scotch-Brite or similar scouring pad. Don't use steel wool as it is difficult, if not impossible, to ensure that there are no strands of it left to cause problems later.

While there was some corrosion on the battery terminals of this cantankerous remote, that was not the problem. It still would not work reliably. There was nothing for it but to pull it apart. This involved removing one screw on the back and then prising the case carefully apart. That revealed a long narrow PC board with just one surface-mount IC, the infrared LED and the contact patterns underneath each rubber button. There were no other components.

Older remotes can be expected to have quite a few components on the board and sometimes the fault can be a fractured component or a broken solder connection. This happens because remote controls are often dropped or sat upon.

In the case of this remote the problem turned out to be blindingly obvious. Not only had quite a lot of food residue worked its way inside the case around the buttons and along the joins in the case but the PC board itself was wet! A sticky liquid was held between the rubber button sheet and the PC board. No doubt someone had spilt drink over it at some stage.

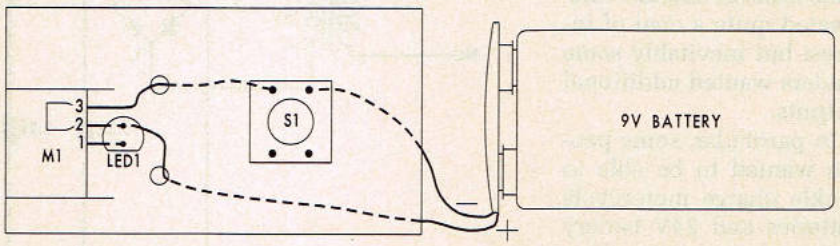


Fig.2: this is the wiring layout of the remote control tester. It uses a surplus PC board which fits into a small plastic case.

Drink residues, especially beer and cola, can be surprisingly hard to remove in this situation and since the PC board was largely bare in this case I decided to clean it up using kitchen detergent, thoroughly rinsed off with clean water. I was sorely tempted to dunk the whole PC board into the washing-up detergent but thought better of it. I also cleaned the rubber keyboard membrane but this job must be done carefully because it easy to inadvertently remove the resistive coating on the back of each button. It is this resistive coating which completes the circuit for each button and activates the remote control.

Having carefully rinsed off all the detergent from the PC board and the keyboard membrane, the drink residue appeared to be completely removed but it turned out not to be the whole cure. While it worked better when it was reassembled, it still would occasionally refuse to respond when some of the buttons were pressed. And even more irritating, sometimes none of the buttons would work! OK, I then cleaned the board and the button membrane again, this time using methylated spirits.

This turned out to be effective and the remote control then worked reliably – for a whole week! At the end of that time, the most used button just fell out! As you might expect, some more unseemly words were uttered. Several times!

There is no way that the missing button could be stuck back into place and since it was the one used to mute the commercials, the whole situation was rather frustrating. But wait! There is a solution. I will replace the missing button with a PC mount snap action switch. They're available from Jaycar, Dick Smith Electronics and Altronics, in various colours for a dollar or so.

Yes, I will have to ream out the button opening in the case but I'm going to fix this remote, come hell or high water! **SC**

Where To Buy The Kit

The complete kit for the remote control tester is available from Oatley Electronics for just $5.95, not including the 9V battery. They also have the infrared detectors available at $2 each or 10 for $15. Oatley Electronics' phone number is (02) 9584 3563; fax (02) 9584 3561.

CIRCUIT NOTEBOOK

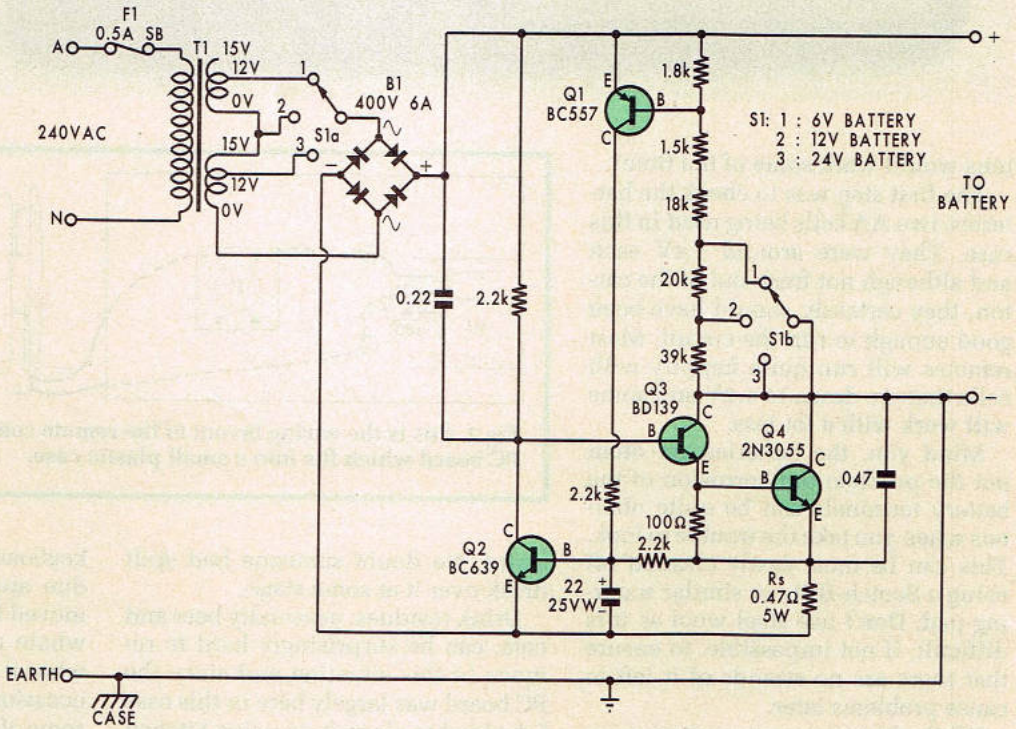
Interesting circuit ideas which we have checked but not built and tested. Contributions from readers are welcome and will be paid for at standard rates.

24V output for trickle charger

The 12V trickle charger featured in the October 1998 issue of SILICON CHIP created quite a deal of interest but inevitably some readers wanted additional outputs.

In particular, some people wanted to be able to trickle charge motorcycle batteries and 24V battery systems in recreational vehicles and on boats.

To achieve this, a bigger transformer and a 2-pole 3-position switch is required. The transformer (Altronics M-2170 or equivalent) has two tapped secondaries which are wired in series as shown on the circuit diagram. One pole of the switch selects the voltage fed to the bridge rectifier, while the other pole varies the voltage monitoring network associated with transistor Q1.



A larger heatsink than before will be required for the 2N3055 power transistor and the larger transformer will necessitate a bigger case than the unit originally specified.

SILICON CHIP.

Timed audible alarm

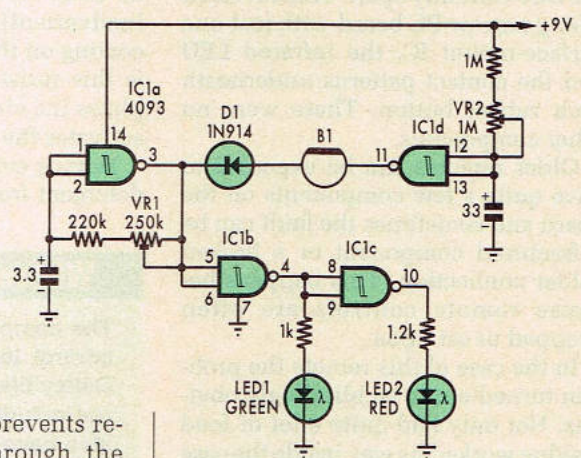
Those readers who were interested in the timed audible alarm in the January 1999 issue of SILICON CHIP may like to consider this circuit which will do the same job.

IC1a, a Schmitt trigger NAND gate, oscillates at a low frequency when power is applied and this signal alternately flashes the green or red LEDs which are driven via IC1b and IC1c, respectively.

Gate IC1d provides the timer part of the circuit. Initially, the 33µF capacitor at pins 12 & 13 is discharged and the output at pin 11 is high. This will cause the piezo buzzer to sound each time the output of IC1a goes low.

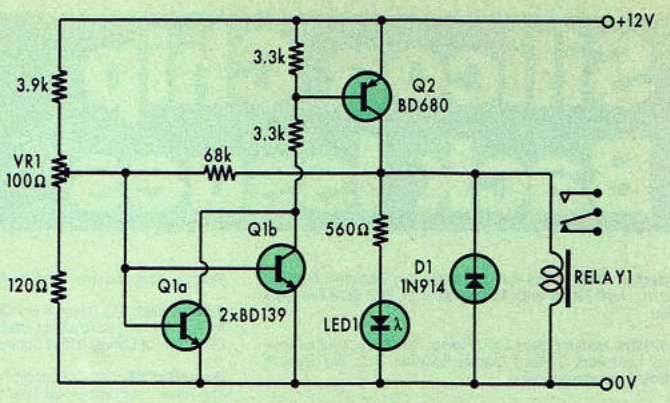
The 33µF capacitor then charges and takes pins 12 & 13 above the input threshold of IC1d and this causes pin 11 to go low, thus stopping the buzzer. The LEDs will continue to flash until the power is removed.

Note that diode D1 prevents reverse current flow through the buzzer when pin 3 is high and pin 11 is low. Note also that the buzzer must have its own inbuilt driver oscillator for this circuit to work.



SILICON CHIP.

Temperature controlled fan for power amplifiers



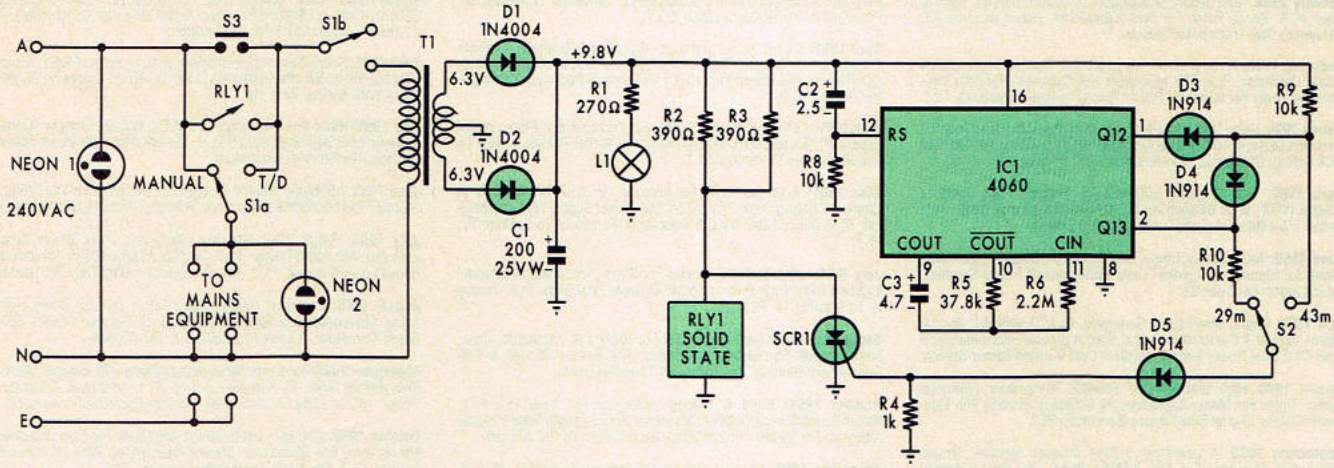
This circuit could be employed to switch the fan for large power amplifiers which require forced-air cooling, especially those with two heatsinks, such as the 500W unit described in the August 1997 issue.

Two transistors are used as temperature sensors and one of these may be mounted on each heatsink. The temperature control method relies on the temperature coefficient of the base-emitter voltage of a silicon transistor. This voltage falls approximately 2mV per degree of temperature rise.

One transistor or two can be used as the temperature sensors, in this case Q1a and Q1b. Their common base-emitter voltage can be set between 350mV and 640mV by trimpot VR1. With a fixed collector current and an ambient temperature of 20°C, the base-emitter voltage (Vbe) of the BD139 is about 625mV. If Vbe is set to say 545mV, the transistor will not conduct until its Vbe falls to 545mV; ie, the junction temperature has to reach 60°C. The BD139s must be fixed to the heatsinks using thermal compound and insulating hardware.

The BD680 driving the relay is a Darlington device. If only one heatsink is used, only one BD139 is required. The LED can be mounted on the front panel to show when the fan is on. The relay can be used to control a 12V fan or a 240VAC fan if it has suitably rated contacts.

S. Williamson,
Hamilton, NZ. ($25)



Bedside lamp/tape recorder timer

This circuit will automatically switch off a bedside light and/or tape player after a nominated time. Sure, there are plenty of timers capable of doing the job but they can be difficult to set, since a start and finishing time is required. For a bedside lamp you don't want to have to set these times each time you use it.

The device described here operates from a single push of a button. It controls both a bedside lamp and a cassette player and you can use either or both. It has two preset times, of 29 and 43 minutes, to cater for common tape lengths.

IC1 is a 4060 timer/oscillator with its oscillator frequency set by the components connected to pins 9, 10 & 11. The components at pin 12 provide a power-on reset. In operation, each of the 10 available outputs go high in sequence and this circuit uses two of those outputs, Q12 & Q13, and these are fed to switch S2 and diodes D3 & D4.

When S2 is set to the 29-minute position, the Q13 output eventually goes high and turns on SCR1. This removes the input voltage from the solid state relay and so the bedside lamp or tape recorder is turned off.

When S2 is set to the 43-minute position, the Q12 and Q13 outputs are fed to an AND gate consisting of diodes D3 & D4. This means that when the Q13 output eventually goes high, the Q12 output is low and so the net output fed to the switch is still low. After a further 15 minutes, Q12 goes high and now both AND gate inputs are high, allowing the SCR to be turned on and the solid state relay to be turned off.

Switch S1 is a convenience that allows you to use the connected appliances (bed light etc.) without initiating the delay circuit. This is the manual position and would presumably be the position you would leave the device in, until the "delayed off" function was required.

Note: solid state relays are available from Farnell Electronic Components. Phone (02) 9645 8888.

Brian Critchley,
Elanora Heights, NSW. ($30)

Silicon Chip Back Issues

September 1988: Hands-Free Speakerphone; Electronic Fish Bite Detector; High Performance AC Millivoltmeter, Pt.2; Build The Vader Voice.

April 1989: Auxiliary Brake Light Flasher; What You Need to Know About Capacitors; 32-Band Graphic Equaliser, Pt.2; The Story Of Amtrak Passenger Services.

May 1989: Build A Synthesised Tom-Tom; Biofeedback Monitor For Your PC; Simple Stub Filter For Suppressing TV Interference; The Burlington Northern Railroad.

July 1989: Exhaust Gas Monitor; Experimental Mains Hum Sniffers; Compact Ultrasonic Car Alarm; The NSW 86 Class Electrics.

September 1989: 2-Chip Portable AM Stereo Radio (Uses MC13024 and TX7376P) Pt.1; High Or Low Fluid Level Detector; Studio Series 20-Band Stereo Equaliser, Pt.2.

October 1989: FM Radio Intercom For Motorbikes Pt.1; GaAsFet Preamplifier For Amateur TV; 2-Chip Portable AM Stereo Radio, Pt.2; A Look At Australian Monorails.

November 1989: Radfax Decoder For Your PC (Displays Fax, RTTY & Morse); FM Radio Intercom For Motorbikes, Pt.2; 2-Chip Portable AM Stereo Radio, Pt.3; Floppy Disc Drive Formats & Options; The Pilbara Iron Ore Railways.

January 1990: High Quality Sine/Square Oscillator; Service Tips For Your VCR; Phone Patch For Radio Amateurs; Active Antenna Kit; Designing UHF Transmitter Stages.

February 1990: A 16-Channel Mixing Desk; Build A High Quality Audio Oscillator, Pt.2; The Incredible Hot Canaries; Random Wire Antenna Tuner For 6 Metres; Phone Patch For Radio Amateurs, Pt.2.

March 1990: Delay Unit For Automatic Antennas; Workout Timer For Aerobics Classes; 16-Channel Mixing Desk, Pt.2; Using The UC3906 SLA Battery Charger IC; The Australian VFT Project.

April 1990: Dual Tracking ±50V Power Supply; Voice-Operated Switch (VOX) With Delayed Audio; 16-Channel Mixing Desk, Pt.3; Active CW Filter; Servicing Your Microwave Oven.

June 1990: Multi-Sector Home Burglar Alarm; Build A Low-Noise Universal Stereo Preamplifier; Load Protector For Power Supplies; Speed Alarm For Your Car.

July 1990: Digital Sine/Square Generator, Pt.1 (0-500kHz); Burglar Alarm Keypad & Combination Lock; Build A Simple Electronic Die; A Low-Cost Dual Power Supply; Inside A Coal Burning Power Station.

August 1990: High Stability UHF Remote Transmitter; Universal Safety Timer For Mains Appliances (9 Minutes); Horace The Electronic Cricket; Digital Sine/Square Generator, Pt.2.

September 1990: A Low-Cost 3-Digit Counter Module; Simple Shortwave Converter For The 2-Metre Band; The Bose Lifestyle Music System (Review); The Care & Feeding Of Battery Packs.

October 1990: The Dangers of PCBs; Low-Cost Siren For Burglar Alarms; Dimming Controls For The Discolight; Surfsound Simulator; DC Offset For DMMs; NE602 Converter Circuits.

November 1990: How To Connect Two TV Sets To One VCR; Build An Egg Timer; Low-Cost Model Train Controller; 1.5V To 9V DC Converter; Introduction To Digital Electronics; Build A Simple 6-Metre Amateur Band Transmitter.

December 1990: The CD Green Pen Controversy; 100W DC-DC Converter For Car Amplifiers; Wiper Pulser For Rear Windows; 4-Digit Combination Lock; 5W Power Amplifier For The 6-Metre Amateur Transmitter; Index To Volume 3.

January 1991: Fast Charger For Nicad Batteries, Pt.1; Have Fun With The Fruit Machine; Two-Tone Alarm Module; LCD Readout For The Capacitance Meter; How Quartz Crystals Work; The Dangers of Servicing Microwave Ovens.

February 1991: Synthesised Stereo AM Tuner, Pt.1; Three Low-Cost Inverters For Fluorescent Lights; Low-Cost Sinewave Oscillator; Fast Charger For Nicad Batteries, Pt.2; How To Design Amplifier Output Stages.

March 1991: Remote Controller For Garage Doors, Pt.1; Transistor Beta Tester Mk.2; A Synthesised AM Stereo Tuner, Pt.2; Multi-Purpose I/O Board For PC-Compatibles; Universal Wideband RF Preamplifier For Amateur Radio & TV.

April 1991: Steam Sound Simulator For Model Railroads; Remote Controller For Garage Doors, Pt.2; Simple 12/24V Light Chaser; Synthesised AM Stereo Tuner, Pt.3; A Practical Approach To Amplifier Design, Pt.2.

May 1991: 13.5V 25A Power Supply For Transceivers; Stereo Audio Expander; Fluorescent Light Simulator For Model Railways; How To Install Multiple TV Outlets, Pt.1.

June 1991: A Corner Reflector Antenna For UHF TV; Build A 4-Channel Lighting Desk, Pt.1; 13.5V 25A Power Supply For Transceivers, Pt.2; Active Filter For CW Reception; Tuning In To Satellite TV, Pt.1.

July 1991: Loudspeaker Protector For Stereo Amplifiers; 4-Channel Lighting Desk, Pt.2; How To Install Multiple TV Outlets, Pt.2; Tuning In To Satellite TV, Pt.2.

September 1991: Digital Altimeter For Gliders & Ultralights; Ultrasonic Switch For Mains Appliances; The Basics Of A/D & D/A Conversion; Plotting The Course Of Thunderstorms.

October 1991: Build A Talking Voltmeter For Your PC, Pt.1; SteamSound Simulator Mk.II; Magnetic Field Strength Meter; Digital Altimeter For Gliders, Pt.2; Military Applications Of R/C Aircraft.

November 1991: Build A Colour TV Pattern Generator, Pt.1; A Junkbox 2-Valve Receiver; Flashing Alarm Light For Cars; Digital Altimeter For Gliders, Pt.3; Build A Talking Voltmeter For Your PC, Pt.2; Build a Turnstile Antenna For Weather Satellite Reception.

December 1991: TV Transmitter For VCRs With UHF Modulators; Infrared Light Beam Relay; Colour TV Pattern Generator, Pt.2; Index To Volume 4.

January 1992: 4-Channel Guitar Mixer; Adjustable 0-45V 8A Power Supply, Pt.1; Baby Room Monitor/FM Transmitter; Experiments For Your Games Card.

March 1992: TV Transmitter For VHF VCRs; Thermostatic Switch For Car Radiator Fans; Coping With Damaged Computer Directories; Guide Valve Substitution In Vintage Radios.

April 1992: IR Remote Control For Model Railroads; Differential Input Buffer For CROs; Understanding Computer Memory; Aligning Vintage Radio Receivers, Pt.1.

May 1992: Build A Telephone Intercom; Electronic Doorbell; Battery Eliminator For Personal Players; Infrared Remote Control For Model Railroads, Pt.2; Aligning Vintage Radio Receivers, Pt.2.

June 1992: Multi-Station Headset Intercom, Pt.1; Video Switcher For Camcorders & VCRs; IR Remote Control For Model Railroads, Pt.3; 15-Watt 12-240V Inverter; A Look At Hard Disc Drives.

August 1992: Automatic SLA Battery Charger; Miniature 1.5V To 9V DC Converter; 1kW Dummy Load Box For Audio Amplifiers; Troubleshooting Vintage Radio Receivers; The MIDI Interface Explained.

October 1992: 2kW 24VDC - 240VAC Sinewave Inverter; Multi-Sector Home Burglar Alarm, Pt.2; Mini Amplifier For Personal Stereos; A Regulated Lead-Acid Battery Charger.

January 1993: Flea-Power AM Radio Transmitter; High Intensity LED Flasher For Bicycles; 2kW 24VDC To 240VAC Sinewave Inverter, Pt.4; Speed Controller For Electric Models, Pt.3.

February 1993: Three Projects For Model Railroads; Low Fuel Indicator For Cars; Audio Level/VU Meter (LED Readout); An Electronic Cockroach; 2kW 24VDC To 240VAC Sinewave Inverter, Pt.5.

March 1993: Solar Charger For 12V Batteries; Alarm-Triggered Security Camera; Reaction Trainer; Audio Mixer for Camcorders; A 24-Hour Sidereal Clock For Astronomers.

April 1993: Solar-Powered Electric Fence; Audio Power Meter; Three-Function Home Weather Station; 12VDC To 70VDC Converter; Digital Clock With Battery Back-Up.

May 1993: Nicad Cell Discharger; Build The Woofer Stopper; Alphanumeric LCD Demonstration Board; The Microsoft Windows Sound System; The Story of Aluminium.

June 1993: AM Radio Trainer, Pt.1; Remote Control For The Woofer Stopper; Digital Voltmeter For Cars; Windows-Based Logic Analyser.

July 1993: Single Chip Message Recorder; Light Beam Relay Extender; AM Radio Trainer, Pt.2; Quiz Game Adjudicator; Windows-Based Logic Analyser, Pt.2; Antenna Tuners – Why They Are Useful.

August 1993: Low-Cost Colour Video Fader; 60-LED Brake Light Array; Microprocessor-Based Sidereal Clock; Southern Cross Z80-Based Computer; A Look At Satellites & Their Orbits.

September 1993: Automatic Nicad Battery Charger/Discharger; Stereo Preamplifier With IR Remote Control, Pt.1; In-Circuit Transistor Tester; +5V to ±15V DC Converter; Remote-Controlled Cockroach.

October 1993: Courtesy Light Switch-Off Timer For Cars; Wireless Microphone For Musicians; Stereo Preamplifier With IR Remote Control, Pt.2; Electronic Engine Management, Pt.1.

ORDER FORM

Buy 10 or more & get a 10% discount

Please send me the following back issues: _____

_____

_____

Enclosed is my cheque/money order for $_____or please debit my: ☐ Bankcard ☐ Visa Card ☐ Master Card

Card No. | | | | | | | | | | | | | | | | |

Signature _____ Card expiry date_____ /_____

Name _____ Phone No (___) _____
PLEASE PRINT

Street _____

Suburb/town _____ Postcode _____

Note: all prices include post & packing

Australia	$A7
NZ & PNG (airmail)	$A8
Overseas (airmail)	$A10

Detach and mail to:
Silicon Chip Publications, PO Box 139, Collaroy, NSW. Australia 2097.

Or call (02) 9979 5644 & quote your credit card details or fax the details to (02) 9979 6503.

November 1993: High Efficiency Inverter For Fluorescent Tubes; Stereo Preamplifier With IR Remote Control, Pt.3; Siren Sound Generator; Engine Management, Pt.2; Experiments For Games Cards.

December 1993: Remote Controller For Garage Doors; LED Stroboscope; 25W Amplifier Module; 1-Chip Melody Generator; Engine Management, Pt.3; Index To Volume 6.

January 1994: 3A 40V Adjustable Power Supply; Switching Regulator For Solar Panels; Printer Status Indicator; Mini Drill Speed Controller; Stepper Motor Controller; Active Filter Design; Engine Management, Pt.4.

February 1994: Build A 90-Second Message Recorder; 12-240VAC 200W Inverter; 0.5W Audio Amplifier; 3A 40V Adjustable Power Supply; Engine Management, Pt.5; Airbags – How They Work.

March 1994: Intelligent IR Remote Controller; 50W (LM3876) Audio Amplifier Module; Level Crossing Detector For Model Railways; Voice Activated Switch For FM Microphones; Simple LED Chaser; Engine Management, Pt.6.

April 1994: Sound & Lights For Model Railway Level Crossings; Discrete Dual Supply Voltage Regulator; Universal Stereo Preamplifier; Digital Water Tank Gauge; Engine Management, Pt.7.

May 1994: Fast Charger For Nicad Batteries; Induction Balance Metal Locator; Multi-Channel Infrared Remote Control; Dual Electronic Dice; Simple Servo Driver Circuits; Engine Management, Pt.8; Passive Rebroadcasting For TV Signals.

June 1994: 200W/350W Mosfet Amplifier Module; A Coolant Level Alarm For Your Car; 80-Metre AM/CW Transmitter For Amateurs; Converting Phono Inputs To Line Inputs; PC-Based Nicad Battery Monitor; Engine Management, Pt.9.

July 1994: Build A 4-Bay Bow-Tie UHF Antenna; PreChamp 2-Transistor Preamplifier; Steam Train Whistle & Diesel Horn Simulator; Portable 6V SLA Battery Charger; Electronic Engine Management, Pt.10.

August 1994: High-Power Dimmer For Incandescent Lights; Microprocessor-Controlled Morse Keyer; Dual Diversity Tuner For FM Microphones, Pt.1; Nicad Zapper; Engine Management, Pt.11.

September 1994: Automatic Discharger For Nicad Battery Packs; MiniVox Voice Operated Relay; Image Intensified Night Viewer; AM Radio For Weather Beacons; Dual Diversity Tuner For FM Microphones, Pt.2; Engine Management, Pt.12.

October 1994: How Dolby Surround Sound Works; Dual Rail Variable Power Supply; Build A Talking Headlight Reminder; Electronic Ballast For Fluorescent Lights; Build A Temperature Controlled Soldering Station; Electronic Engine Management, Pt.13.

November 1994: Dry Cell Battery Rejuvenator; Novel Alphanumeric Clock; 80-Metre DSB Amateur Transmitter; Twin-Cell Nicad Discharger (See May 1993); How To Plot Patterns Direct to PC Boards.

December 1994: Dolby Pro-Logic Surround Sound Decoder, Pt.1; Easy-To-Build Car Burglar Alarm; Three-Spot Low Distortion Sinewave Oscillator; Clifford – A Pesky Electronic Cricket; Remote Control System for Models, Pt.1; Index to Vol.7.

January 1995: Sun Tracker For Solar Panels; Battery Saver For Torches; Dolby Pro-Logic Surround Sound Decoder, Pt.2; Dual Channel UHF Remote Control; Stereo Microphone Preamplifier.

February 1995: 50-Watt/Channel Stereo Amplifier Module; Digital Effects Unit For Musicians; 6-Channel Thermometer With LCD Readout; Wide Range Electrostatic Loudspeakers, Pt.1; Oil Change Timer For Cars; Remote Control System For Models, Pt.2.

March 1995: 50 Watt Per Channel Stereo Amplifier, Pt.1; Subcarrier Decoder For FM Receivers; Wide Range Electrostatic Loudspeakers, Pt.2; IR Illuminator For CCD Cameras; Remote Control System For Models, Pt.3; Simple CW Filter.

April 1995: FM Radio Trainer, Pt.1; Photographic Timer For Darkrooms; Balanced Microphone Preamp. & Line Filter; 50W/Channel Stereo Amplifier, Pt.2; Wide Range Electrostatic Loudspeakers, Pt.3; 8-Channel Decoder For Radio Remote Control.

May 1995: What To Do When the Battery On Your PC's Motherboard Goes Flat; Build A Guitar Headphone Amplifier; FM Radio Trainer, Pt.2; Transistor/Mosfet Tester For DMMs; A 16-Channel Decoder For Radio Remote Control; Introduction to Satellite TV.

June 1995: Build A Satellite TV Receiver; Train Detector For Model Railways; 1W Audio Amplifier Trainer; Low-Cost Video Security System; Multi-Channel Radio Control Transmitter For Models, Pt.1; Build A $30 Digital Multimeter.

July 1995: Electric Fence Controller; How To Run Two Trains On A Single Track (Incl. Lights & Sound); Setting Up A Satellite TV Ground Station; Build A Reliable Door Minder; Adding RAM To A Computer.

August 1995: Fuel Injector Monitor For Cars; Gain Controlled Microphone Preamp; Audio Lab PC Controlled Test Instrument, Pt.1; Mighty-Mite Powered Loudspeaker; How To Identify IDE Hard Disc Drive Parameters.

September 1995: Keypad Combination Lock; The Incredible Vader Voice; Railpower Mk.2 Walkaround Throttle For Model Railways, Pt.1; Jacob's Ladder Display; The Audio Lab PC Controlled Test Instrument, Pt.2.

October 1995: Geiger Counter; 3-Way Bass Reflex Loudspeaker System; Railpower Mk.2 Walkaround Throttle For Model Railways, Pt.2; Fast Charger For Nicad Batteries; Digital Speedometer & Fuel Gauge For Cars, Pt.1.

November 1995: Mixture Display For Fuel Injected Cars; CB Transverter For The 80M Amateur Band, Pt.1; PIR Movement Detector; Dolby Pro Logic Surround Sound Decoder Mk.2, Pt.1; Digital Speedometer & Fuel Gauge For Cars, Pt.2.

December 1995: Engine Immobiliser; 5-Band Equaliser; CB Transverter For The 80M Amateur Band, Pt.2; Subwoofer Controller; Dolby Pro Logic Surround Sound Decoder Mk.2, Pt.2; Knock Sensing In Cars; Index To Volume 8.

January 1996: Surround Sound Mixer & Decoder, Pt.1; Magnetic Card Reader; Build An Automatic Sprinkler Controller; IR Remote Control For The Railpower Mk.2; Recharging Nicad Batteries For Long Life.

February 1996: Three Remote Controls To Build; Woofer Stopper Mk.2; 10-Minute Kill Switch For Smoke Detectors; Basic Logic Trainer; Surround Sound Mixer & Decoder, Pt.2; Use your PC As A Reaction Timer.

March 1996: Programmable Electronic Ignition System; Zener Diode Tester For DMMs; Automatic Level Control For PA Systems; 20ms Delay For Surround Sound Decoders; Multi-Channel Radio Control Transmitter; Pt.2; Cathode Ray Oscilloscopes, Pt.1.

April 1996: Cheap Battery Refills For Mobile Telephones; 125W Power Amplifier Module; Knock Indicator For Leaded Petrol Engines; Multi-Channel Radio Control Transmitter; Pt.3; Cathode Ray Oscilloscopes, Pt.2.

May 1996: Upgrading The CPU In Your PC; Build A High Voltage Insulation Tester; Knightrider Bi-Directional LED Chaser; Simple Duplex Intercom Using Fibre Optic Cable; Cathode Ray Oscilloscopes, Pt.3.

June 1996: BassBox CAD Loudspeaker Software Reviewed; Stereo Simulator (uses delay chip); Rope Light Chaser; Low Ohms Tester For Your DMM; Automatic 10A Battery Charger.

July 1996: Installing a Dual Boot Windows System On Your PC; Build A VGA Digital Oscilloscope, Pt.1; Remote Control Extender For VCRs; 2A SLA Battery Charger; 3-Band Parametric Equaliser; Single Channel 8-bit Data Logger.

August 1996: Electronics on the Internet; Customising the Windows Desktop; Introduction to IGBTs; Electronic Starter For Fluorescent Lamps; VGA Oscilloscope, Pt.2; 350W Amplifier Module; Masthead Amplifier For TV & FM; Cathode Ray Oscilloscopes, Pt.4.

September 1996: VGA Oscilloscope, Pt.3; IR Stereo Headphone Link, Pt.1; High Quality PA Loudspeaker; 3-Band HF Amateur Radio Receiver; Feedback On Programmable Ignition (see March 1996); Cathode Ray Oscilloscopes, Pt.5.

October 1996: Send Video Signals Over Twisted Pair Cable; Power Control With A Light Dimmer; 600W DC-DC Converter For Car Hifi Systems, Pt.1; IR Stereo Headphone Link, Pt.2; Multi-Media Sound System, Pt.1; Multi-Channel Radio Control Transmitter, Pt.8.

November 1996: Adding A Parallel Port To Your Computer; 8-Channel Stereo Mixer, Pt.1; Low-Cost Fluorescent Light Inverter; How To Repair Domestic Light Dimmers; Multi-Media Sound System, Pt.2; 600W DC-DC Converter For Car Hifi Systems, Pt.2.

December 1996: CD Recorders – The Next Add-On For Your PC; Active Filter Cleans Up CW Reception; Fast Clock For Railway Modellers; Laser Pistol & Electronic Target; Build A Sound Level Meter; 8-Channel Stereo Mixer, Pt.2; Index To Volume 9.

January 1997: How To Network Your PC; Control Panel For Multiple Smoke Alarms, Pt.1; Build A Pink Noise Source (For Sound Level Meter Calibration); Computer Controlled Dual Power Supply, Pt.1; Digi-Temp Monitors Eight Temperatures.

February 1997: Cathode Ray Oscilloscopes, Pt.6; PC-Controlled Moving Message Display; Computer Controlled Dual Power Supply, Pt.2; Alert-A-Phone Loud Sounding Alarm; Control Panel For Multiple Smoke Alarms, Pt.2.

March 1997: Driving A Computer By Remote Control; Plastic Power PA Amplifier (175W); Signalling & Lighting For Model Railways; Build A Jumbo LED Clock; Audible Continuity Tester; Cathode Ray Oscilloscopes, Pt.7.

April 1997: Avoiding Win95 Hassles With Motherboard Upgrades; Simple Timer With No ICs; Digital Voltmeter For Cars; Loudspeaker Protector For Stereo Amplifiers; Model Train Controller; A Look At Signal Tracing; Pt.1; Cathode Ray Oscilloscopes, Pt.8.

May 1997: Windows 95 – The Hardware Required; Teletext Decoder For PCs; Build An NTSC-PAL Converter; Neon Tube Modulator For Light Systems; Traffic Lights For A Model Intersection; The Spacewriter – It Writes Messages In Thin Air; A Look At Signal Tracing; Pt.2; Cathode Ray Oscilloscopes, Pt.9.

June 1997: Tuning Up Your Hard Disc Drive; PC-Controlled Thermometer/Thermostat; Colour TV Pattern Generator, Pt.1; Build An Audio/RF Signal Tracer; High-Current Speed Controller For 12V/24V Motors; Manual Control Circuit For A Stepper Motor; Fail-Safe Module For The Throttle Servo; Cathode Ray Oscilloscopes, Pt.10.

July 1997: Infrared Remote Volume Control; A Flexible Interface Card For PCs; Points Controller For Model Railways; Simple Square/Triangle Waveform Generator; Colour TV Pattern Generator, Pt.2; An In-Line Mixer For Radio Control Receivers; How Holden's Electronic Control Unit works, Pt.1.

August 1997: The Bass Barrel Subwoofer; 500 Watt Audio Power Amplifier Module; A TENs Unit For Pain Relief; Addressable PC Card For Stepper Motor Control; Remote Controlled Gates For Your Home; How Holden's Electronic Control Unit Works, Pt.2.

September 1997: Multi-Spark Capacitor Discharge Ignition; 500W Audio Power Amplifier, Pt.2; A Video Security System For Your Home; PC Card For Controlling Two Stepper Motors; HiFi On A Budget; Win95, MSDOS.SYS & The Registry.

October 1997: Build A 5-Digit Tachometer; Add Central Locking To Your Car; PC-Controlled 6-Channel Voltmeter; The Flickering Flame Stage Prop; 500W Audio Power Amplifier, Pt.3; Customising The Windows 95 Start Menu.

November 1997: Heavy Duty 10A 240VAC Motor Speed Controller; Easy-To-Use Cable & Wiring Tester; Regulated Supply For Darkroom Lamps; Build A Musical Doorbell; Relocating Your CD-ROM Drive; Replacing Foam Speaker Surrounds; Understanding Electric Lighting Pt.1.

December 1997: A Heart Transplant For An Aging Computer; Build A Speed Alarm For Your Car; Two-Axis Robot With Gripper; Loudness Control For Car Hifi Systems; Stepper Motor Driver With Onboard Buffer; Power Supply For Stepper Motor Cards; Understanding Electric Lighting Pt.2; Index To Volume 10.

January 1998: Build Your Own 4-Channel Lightshow, Pt.1 (runs off 12VDC or 12VAC); Command Control System For Model Railways, Pt.1; Pan Controller For CCD Cameras; Build A One Or Two-Lamp Flasher; Understanding Electric Lighting, Pt.3.

February 1998: Hot Web Sites For Surplus Bits; Multi-Purpose Fast Battery Charger, Pt.1; Telephone Exchange Simulator For Testing; Command Control System For Model Railways, Pt.2; Demonstration Board For Liquid Crystal Displays; Build Your Own 4-Channel Lightshow, Pt.2; Understanding Electric Lighting, Pt.4.

April 1998: Automatic Garage Door Opener, Pt.1; 40V 8A Adjustable Power Supply, Pt.1; PC-Controlled 0-30kHz Sinewave Generator; Build A Laser Light Show; Philips DVD840 Digital Video Disc Player (Review); Understanding Electric Lighting; Pt.6; Jet Engines In Model Aurcraft.

May 1998: Troubleshooting Your PC, Pt.1; Build A 3-LED Logic Probe; A Detector For Metal Objects; Automatic Garage Door Opener, Pt.2; Command Control For Model Railways, Pt.4; 40V 8A Adjustable Power Supply, Pt.2.

June 1998: Troubleshooting Your PC, Pt.2; Understanding Electric Lighting, Pt.7; Universal High Energy Ignition System; The Roadies' Friend Cable Tester; Universal Stepper Motor Controller; Command Control For Model Railways, Pt.5.

July 1998: Troubleshooting Your PC, Pt.3 (Installing A Modem And Sorting Out The Problems); Build A Heat Controller; 15-Watt Class-A Amplifier Module; Simple Charger For 6V & 12V SLA Batteries; An Automatic Semiconductor Analyser; Understanding Electric Lighting, Pt.8.

August 1998: Troubleshooting Your PC, Pt.4 (Adding Extra Memory To Your PC); Build The Opus One Loudspeaker System; Simple I/O Card With Automatic Data Logging; Build A Beat Triggered Strobe; A 15-Watt Per Channel Class-A Stereo Amplifier.

September 1998: Troubleshooting Your PC, Pt.5 (Software Problems & DOS Games); A Blocked Air-Filter Alarm; A Waa-Waa Pedal For Your Guitar; Build A Plasma Display Or Jacob's Ladder; Gear Change Indicator For Cars; Capacity Indicator For Rechargeable Batteries.

October 1998: CPU Upgrades & Overclocking; Lab Quality AC Millivoltmeter, Pt.1; PC-Controlled Stress-O-Meter; Versatile Electronic Guitar Limiter; 12V Trickle Charger For Float Conditions; Adding An External Battery Pack To Your Flashgun.

November 1998: Silicon Chip On The World Wide Web; The Christmas Star (Microprocessor-Controlled Christmas Decoration); A Turbo Timer For Cars; Build Your Own Poker Machine, Pt.1; FM Transmitter For Musicians; Lab Quality AC Millivoltmeter, Pt.2; Beyond The Basic Network (Setting Up A LAN Using TCP/IP); Understanding Electric Lighting, Pt.9; Improving AM Radio Reception, Pt.1.

December 1998: Protect Your Car With The Engine Immobiliser Mk.2; Thermocouple Adaptor For DMMs; A Regulated 12V DC Plugpack; Build Your Own Poker Machine, Pt.2; GM's Advanced Technology Vehicles; Improving AM Radio Reception, Pt.2; Mixer Module For F3B Glider Operations.

January 1999: The Y2K Bug & A Few Other Worries; High-Voltage Megohm Tester; Getting Going With BASIC Stamp; LED Bargraph Ammeter For Cars; Keypad Engine Immobiliser; Improving AM Radio Reception, Pt.3; Electric Lighting, Pt.10

PLEASE NOTE: November 1987 to August 1988, October 1988 to March 1989, June 1989, August 1989, December 1989, May 1990, August 1991, February 1992, July 1992, September 1992, November 1992, December 1992 and March 1998 are now sold out. All other issues are presently in stock. For readers wanting articles from sold-out issues, we can supply photostat copies (or tear sheets) at $7.00 per article (includes p&p). When supplying photostat articles or back copies, we automatically supply any relevant notes & errata at no extra charge. A complete index to all articles published to date is available on floppy disc for $10 including p&p, or can be downloaded free from our web site: www.siliconchip.com.au

Electric Lighting

Pt.11: High Intensity Discharge Lighting For Cars

BY JULIAN EDGAR

The headlights in some prestige cars no longer use incandescent lamps. Instead, metal halide gas discharge lights are used and these have several advantages.

High Intensity Discharge lights are widely used in industrial, commercial and outdoor environments. They include high-pressure mercury lamps, high and low-pressure sodium vapour lamps, and metal halide lamps (see earlier articles in this series). But although such lights have been in use for many years, the incandescent lamp has reigned supreme in automotive headlights until quite recently.

Now, manufacturers of luxury cars such as Lexus and BMW are introducing High Intensity Discharge (HID) headlights on their vehicles. Lighting manufacturer Hella has also recently released the Predator auxiliary driving light, which uses the same technology.

The advantages of HID lighting include: (1) a higher colour temperature, resulting in better visibility and sign recognition; (2) better efficacy; (3) a very long bulb life; and (4) a distinctive blue/white light appearance – which has some advantages for vehicle manufacturers wanting to display their technical prowess. Fig.1 shows the differences in a scene illuminated by conventional halogen incandescent illumination (top) and by Bosch High Intensity Discharge lighting (bottom).

Xenon Metal Halide Lamps

The new HID automotive lighting systems use metal halide lamps. These lamps are filled with mercury, metal halides and xenon gas. When a high ignition voltage is applied to the electrodes, the xenon gas in the quartz bulb emits light. The starting voltage initially applied varies from manufacturer to manufacturer – Hella use a starting pulse of 25kV, Lexus 20kV and Bosch 6-12kV. During the starting phase, the Bosch Litronic system can apply a current of up to 2.6A, which is substantially more than the continuous operating current of approximately 0.4A.

This initial pulse gives the very quick start-up required in a headlight application, with the xenon gas al-

most immediately emitting visible light. As the temperature of the bulb rises, the mercury vaporises, allowing the discharge to occur. After that, the metal halides in the mercury arc separate and the lamp operates at full brightness. Full illumination occurs when the quartz bulb reaches its operating temperature of almost 1000°K.

Fig.2 shows a High Intensity Discharge headlight, as fitted to the Lexus GS300.

Performance

As you might expect, the new HID lighting systems have quite a performance advantage over incandescent systems. The 35 watt 'D-1' bulb in the Bosch Litronic system, for example, emits a luminous flux of 3000 lumens, almost twice the intensity of an incandescent H1 halogen lamp. Hella state that their 35W Predator spotlight generates a luminance of 6000 cd/cm^2. By contrast, a 100W H1 halogen globe in the same luminaire provides a luminance of just 2500 cd/cm^2.

The colour temperature of HID lighting is also higher (4500°K) than for conventional incandescent halogen lamps. Relatively large components of green and blue wavelengths are emitted, giving the light an appearance very similar to sunlight.

The life of the Bosch lamp is quoted at 1500 hours, which roughly equates to the total expected operating time during a vehicle's life. Hella go even further, suggesting that their HID lamp will last for 2500 hours – approximately 50 times the life of a 100W H1 halogen bulb! In addition, if failure does occur, it doesn't happen suddenly as with incandescent lamps.

Another major advantage of the HID lamps is their lack of susceptibility to vibration. This makes the HID lights very suitable for harsh environments such as mining and off-road applications. The Hella spotlights are already being used in professional rallying. The much higher efficacy of HID lights results in a reduced current draw for the same degree of illuminance. Two 35W Hella Predators provide better illuminance than four 100W incandescent driving lights, while at the same time reducing the current drawn from 33A to 5.8A (at a nominal 13.8V).

The use of HID lights in combined high/low beam applications has occurred only very recently. Bosch's third generation Litronic system has high and low-beam capability within the one headlight. Headlight dipping can be achieved in two different ways. The first technique moves a shield within the luminaire, simply blocking off the high beam component. The second technique moves the bulb

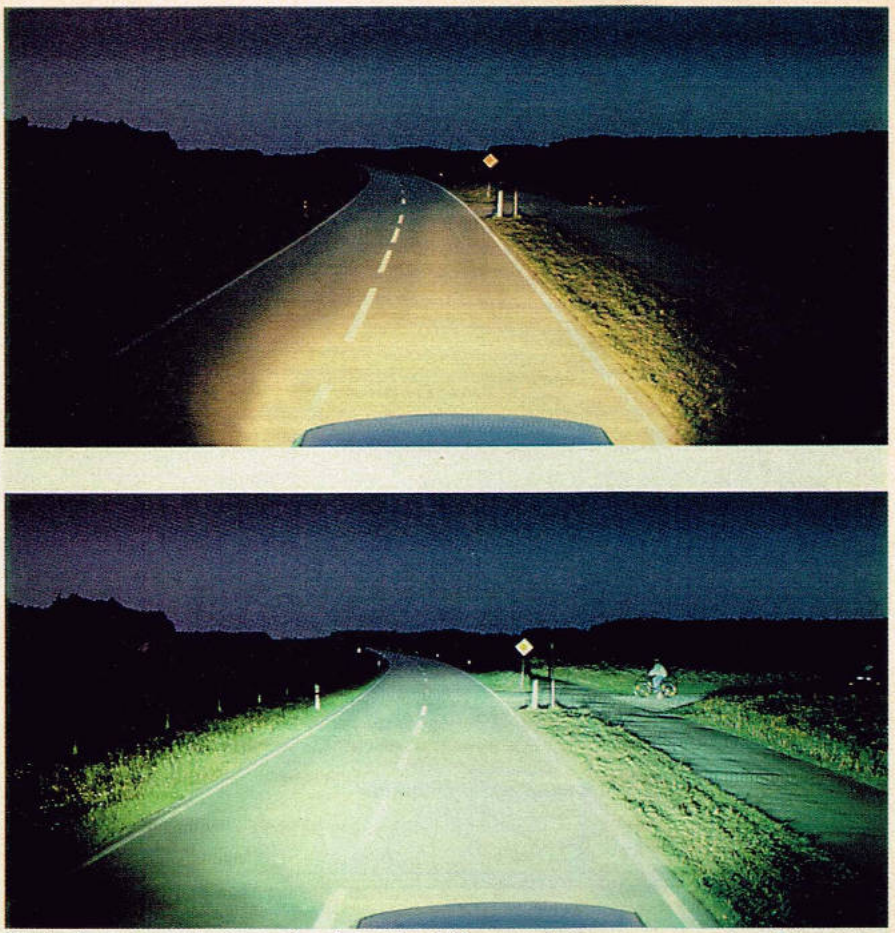


Fig.1: these two photographs show the difference between conventional tungsten halogen lighting (top) and High Intensity Discharge (HID) lighting (above). Note the presence of the cyclist to the right in both pictures! (Bosch).

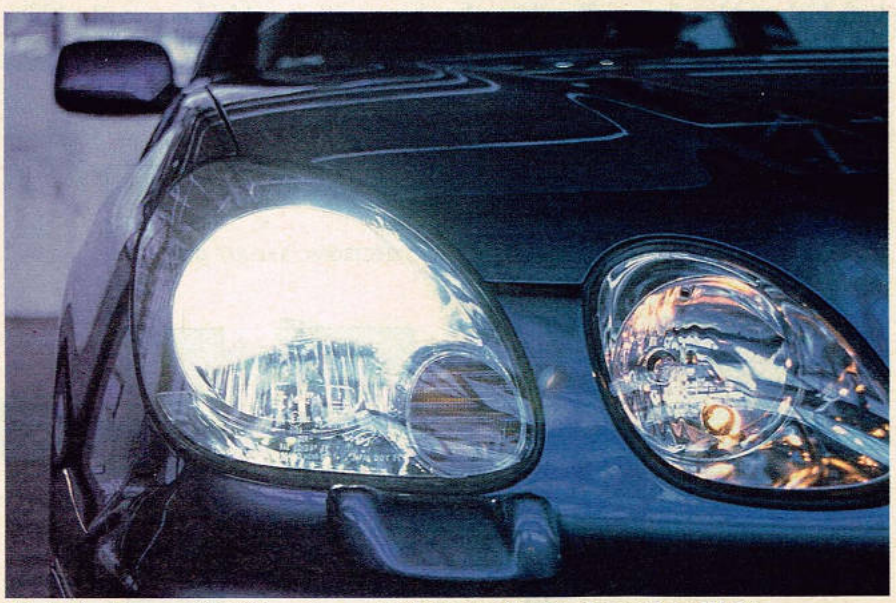


Fig.2: the Lexus GS300 low-beam High Intensity Discharge headlight.

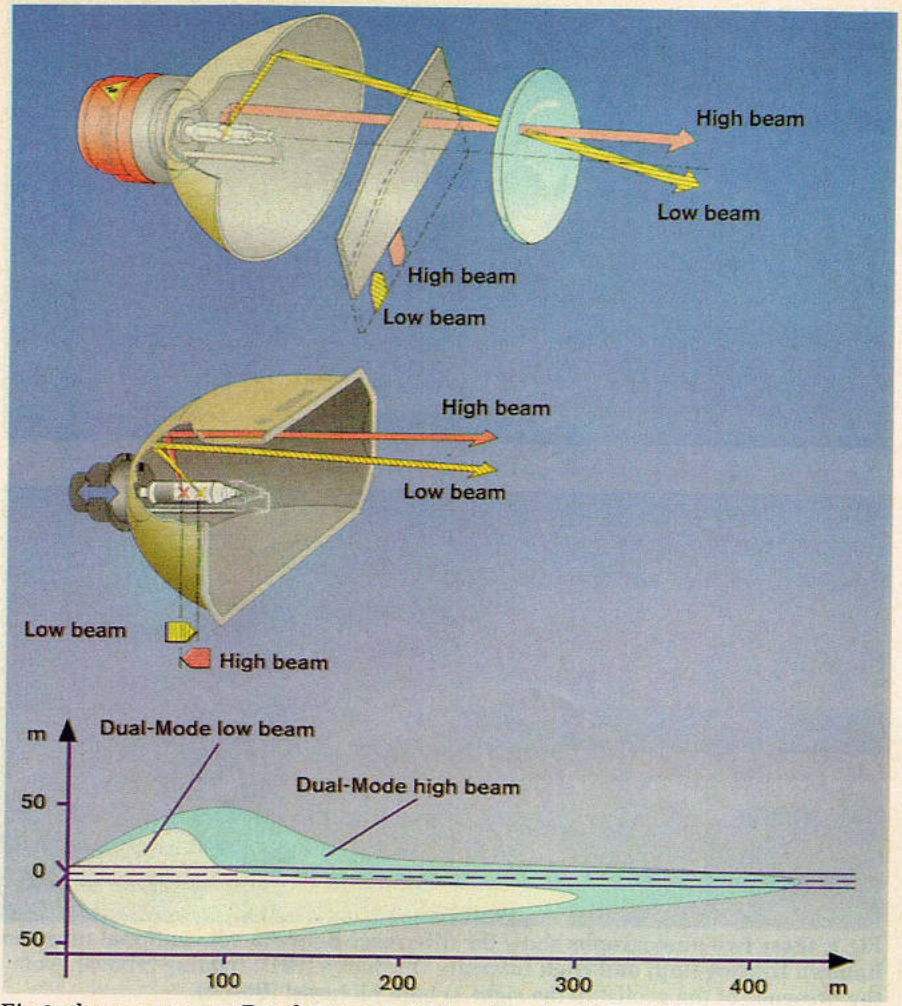


Fig.3: the most recent Bosch Litronic HID system has the ability to operate on both high and low beams. To achieve low beam, either a shield is moved within the luminaire (top) or the bulb itself is moved (middle). The resulting beam spreads are shown at the bottom of the diagram. Note that a righthand drive perspective is used. (Bosch).

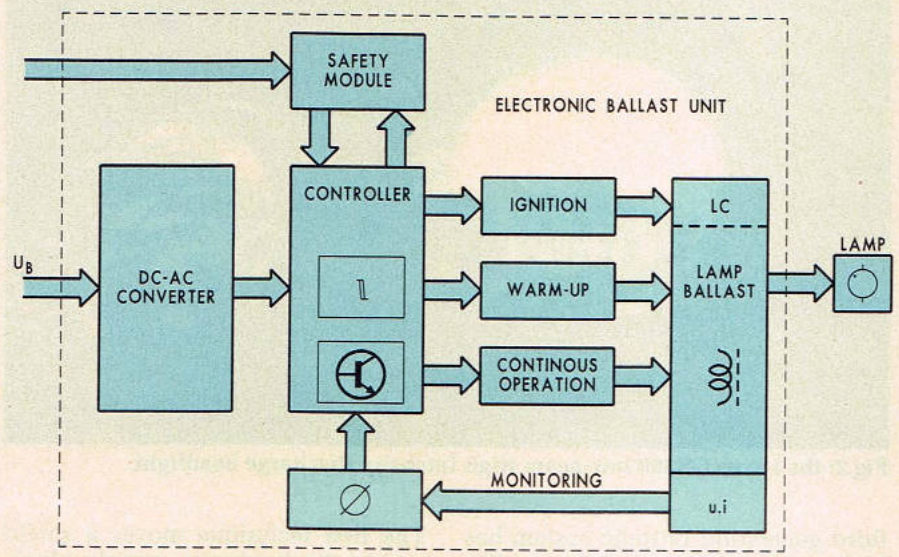


Fig.4: the Bosch Litronic electronic control circuit includes several fail-safe systems. It even switches off the headlamp if damage occurs to the headlight's glass or if the lamp connection is exposed. (Bosch).

within the luminaire. Fig.3 shows these techniques and the beam patterns that result.

Electronic ballast

The main functions of the electronic control system are to:
(1) ignite the gaseous discharge;
(2) regulate the current supply during the warm-up phase;
(3) regulate the current supply during normal operation;
(4) provide fail-safe operation.

Fig.4 shows a schematic diagram of the Bosch Litronic system's electronic control circuit. A frequency of 10kHz is used.

The fail-safe functions of the controller are extensive. The Bosch system switches off the headlamp if damage occurs to the headlight's glass or if the lamp connection is exposed. Interestingly, one reason that the lamp is extinguished with a broken lens is to reduce the chance of UV exposure.

The Lexus system switches off the headlights if a voltage outside the 9-16V operating range is detected, turning them back on again if the input voltage reverts to normal. However, if the lights are already illuminated and the battery voltage falls, the lamps will stay on until there is insufficient voltage for their discharge to be maintained. If an open circuit (including a missing bulb), short circuit or flashing bulb is detected, the Light Control Computer switches off the power to the lights.

In all systems, the electronic ballast is located in close proximity to the light that it controls. Fig.5 shows the layout of a first-generation Bosch Litronic system.

Lamp level control

The very high intensity of HID lamps makes appropriate headlight level control very important. An interesting solution to this problem has been adopted on the Lexus models, which use a computer-controlled stepper motor system to automatically swivel the reflectors within their housings.

Information for the "Headlight Levelling" ECU, which controls the stepper motors, is derived from a number of sources. First, height sensors are fitted to the suspension of one front wheel and one back wheel. The information from these is fed directly to the ECU, along with information on

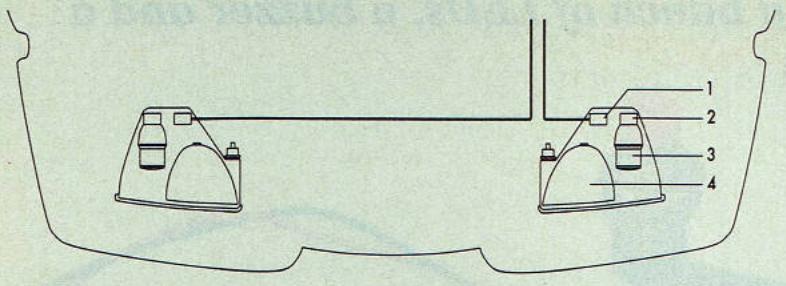


Fig.5: the first generation Bosch Litronic system used conventional lights for high beam. The main components of this system were: (1) electronic ballast unit with controller; (2) high voltage section; (3) HID projector (low beam); (4) conventional high beam. (Bosch).

Fig.6: the most recent Bosch design integrates headlight level control into the HID system. (Bosch).

the individual wheel speeds as derived from the ABS (anti-lock braking system) sensors.

As the vehicle is being driven, the Headlight Levelling ECU calculates vehicle pitch from the suspension height sensors and the model's wheelbase. The headlight reflectors are then automatically adjusted to give the optimum beam angle. The reason that a wheel speed input is required is because the reflectors default to a predetermined initial setting if the speed is below 1.9 km/h.

The most recent Litronic system from Bosch includes headlight level control as an integral part of the system. Fig.6 shows the appearance of this system.

Fig.7: this is the "Predator" driving light from Hella. Two 35W Predators outperform four conventional 100W driving lights, while reducing the current consumption from 33A to just 5.8A.

Conclusion

As with other electronic automotive innovations (eg, anti-lock brakes and airbags), the technology of HID lighting is almost certain to trickle down to medium-level cars in the near future. Your next car could well use HID headlights. **SC**

SPEAKER DRIVERS & PARTS

DYNAUDIO, PEERLESS, SCAN-SPEAK & VIFA DRIVERS FROM DENMARK
• SOLEN AND BENNIC CAPACITORS
• FLARED BASS REFLEX PORTS
• TERMINALS • INDUCTORS
• DEFLEX DAMPING PRODUCTS

Australia's largest seller of quality Danish hi-fi speakers drivers. For free information on all our speaker drivers and parts, call Scan Audio or send $15 for **new** catalogue with complete data sheets on 93 different speaker drivers. Price includes air mail postage anywhere in Australia or NZ.

Scan audio

PO Box 242 Hawthorn Victoria 3122
Tel (03)**9429 2199** Fax (03)**9429 9309**

ELECTRONIC COMPONENTS & ACCESSORIES

- RESELLER FOR MAJOR KIT RETAILERS
- PROTOTYPING EQUIPMENT
- CB RADIO SALES AND ACCESSORIES
- FULL ON-SITE SERVICE AND REPAIR FACILITIES
- LARGE RANGE OF ELECTRONIC DISPOSALS (COME IN AND BROWSE)

Croydon
Ph (03) 9723 3860
Fax (03) 9725 9443

Mildura
Ph (03) 5023 8138
Fax (03) 5023 8511

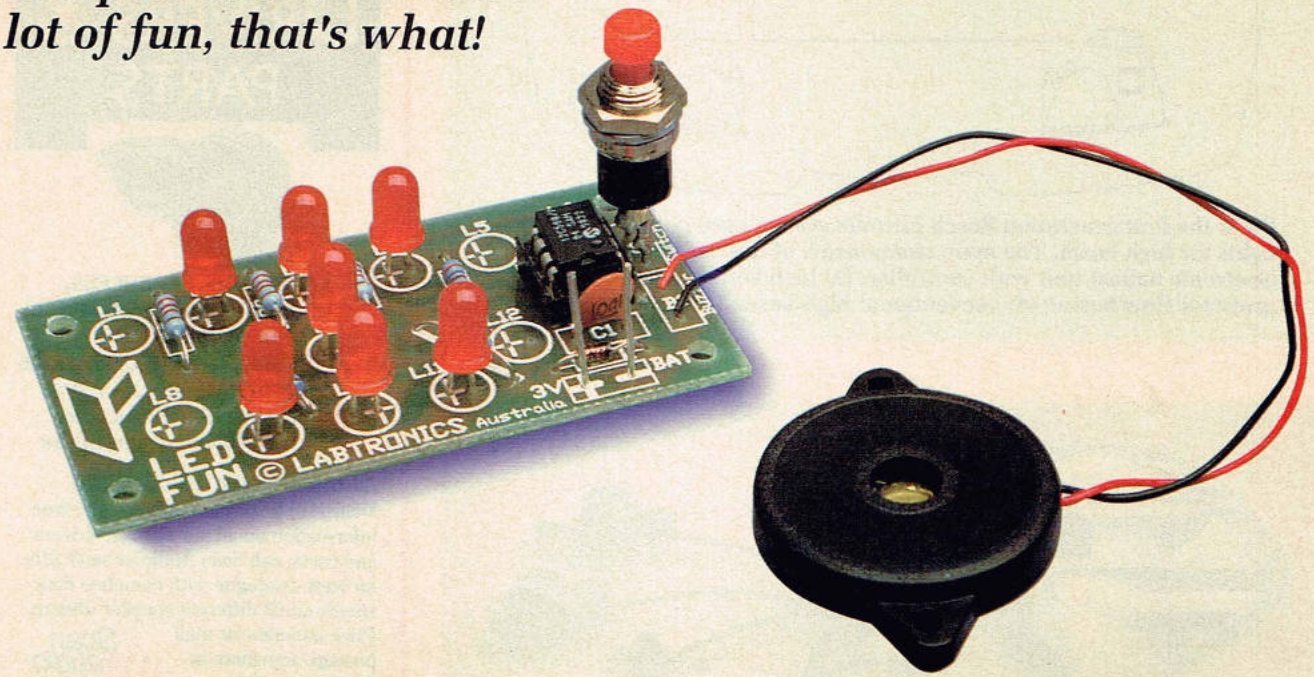
MAIL ORDER WELCOME

Truscott's
ELECTRONIC WORLD Pty Ltd
ACN 069 935 397

30 Lacey St
Croydon Vic 3136

24 Langtree Ave
Mildura Vic 3500

What can you do with a bunch of LEDs, a buzzer and a PIC processor? Have a lot of fun, that's what!



LEDS HAVE FUN!

By LEO SIMPSON

This little project has no less than eight modes of operation including random and chaser displays, doorbell and alarm. It will only take you 10 minutes to build it.

Designed and produced in Australia, LED FUN is a kit based on a PIC microcontroller and its small PC board can be assembled to provide a wide range of operating modes.

Let's just list the eight possible modes and their variations.

Mode 1 is a random LED display. Press the pushbutton and the LEDs chase, slow down and stop randomly. The piezo buzzer clicks in time with the LEDs lighting to give an acoustic accompaniment. You could use this as a dice for a board game.

Mode 2 is a LED chaser with three patterns which are played in sequence. The first is a straight chaser whereby the LEDs follow each other and then loop back to start.

Second, the LEDs follow each other and stay on to the end and third is a strobe whereby the LEDs all flash on in unison.

To use it, you press the pushbutton and the LED pattern starts, slows down and then picks up in speed. You release the button when the speed you want is happening. You can then press the button and hold again for the speed of the next pattern.

Mode 3 is a binary count-down

timer. You can set it to provide a count-down period of one to 64 seconds and at the end of that time the buzzer sounds for five seconds. To set it, you press the button and hold it for the required time. The counter then times out, sounds the alarm and flashes the LEDs for five seconds. It can then be reset for the same time by pressing the button again.

Mode 4 is a ladder reaction game. You get to climb the 6-LED ladder if your reactions are quick.

To use it, you press the button each time you hear a clock and a LED flashes. You must press it very quickly to keep the LED alight at that level. Then the next LED flashes and you must press the button again. If you're really good, you'll get to the top.

Mode 5 is a blinking face display using all seven LEDs. It blinks randomly and changes expressions by turning off some of the LEDs.

Mode 6 is a doorbell/alarm with the blinking face and buzzer.

Mode 7 is a memory sequence game. You start it and it gives a sequence of a dots and dashes from the buzzer and a LED which you must repeat with the pushbutton.

Get it right and the blinking face flashes and the buzzer plays a tune as your reward. The sequences then get longer and harder and it is up to you to keep persevering.

Mode 8 is a dice employing all seven LEDs in the correct pattern. You press the button and the dice chases and then stops randomly. You then "toss" again by pressing the button. You can use it anywhere you would use a dice.

All these functions are programmed into the PIC microcontroller and all you need to do is assemble the board. Fig.1 shows the circuit and as you can see, there is very little to it.

To select the actual mode you want, you install the LEDs and resistors according to Table 1. All the resistors in Table 1 have the same value of 2.2kΩ.

TABLE 1		
Mode	**Resistor**	**LEDs**
1	none	1-6
2	R4 only	1-6
3	R3 only	1-6
4	R3,R4	1-6
5	R2 only	2,4,8-12
6	R2,R4	2,4,8-12
7	R2,R3	2,4,8-12
8	R2,R3,R4	2-4,7,9-11
NB: R2, R3 & R4 are all 2.2kΩ		

Use this table to select the parts you need to install for the various modes of operation.

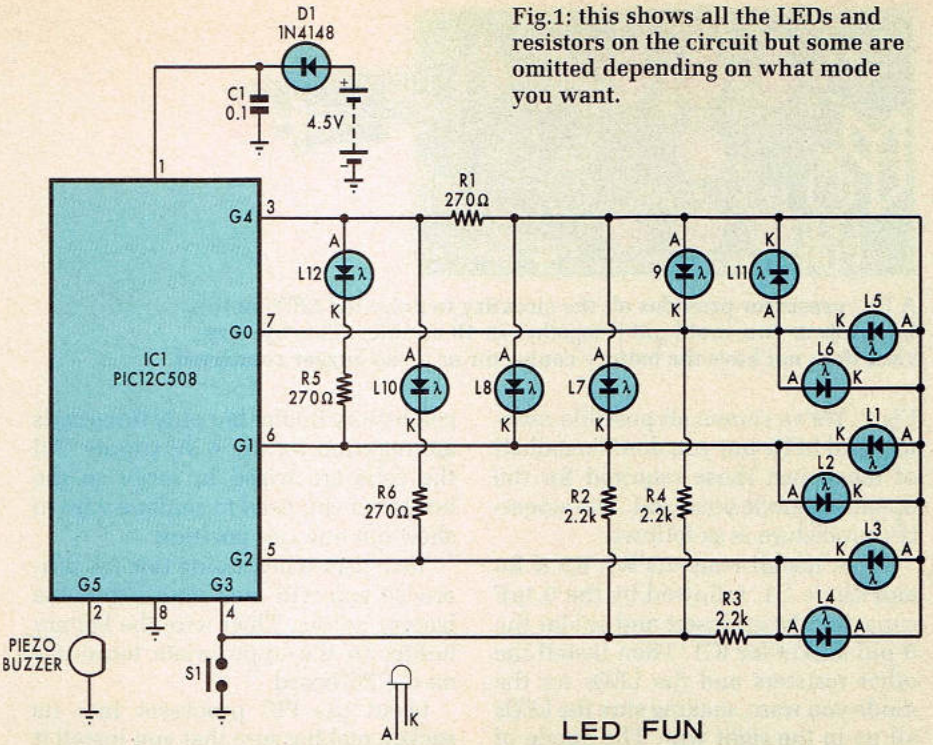


Fig.1: this shows all the LEDs and resistors on the circuit but some are omitted depending on what mode you want.

Board assembly

The board measures just 68 x 34mm. Its component layout is shown in

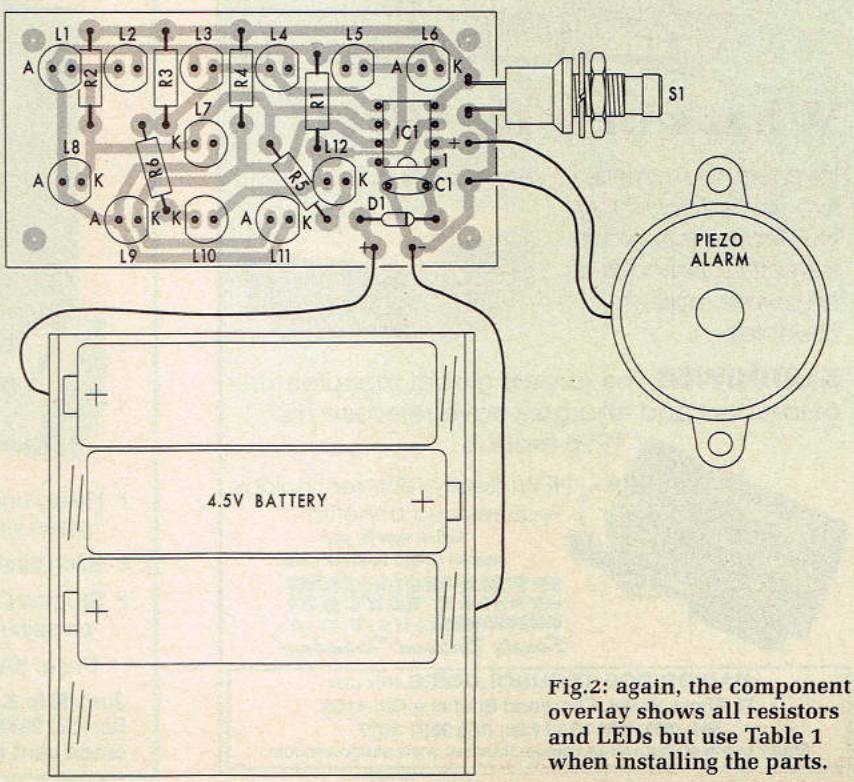
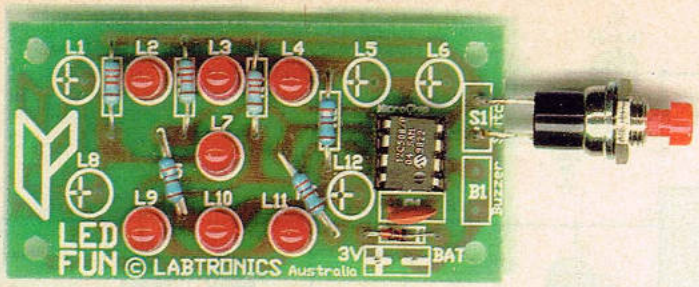


Fig.2: again, the component overlay shows all resistors and LEDs but use Table 1 when installing the parts.



A PIC processor provides all the circuitry to drive the LEDs in this fun project. You could put it together in 10 minutes. This life-size view does not have the battery connector or piezo buzzer connected.

Fig.2. We've shown all possible resistors and LEDs but you don't install all of them, just those required for the operating mode you want. The assembly procedure is as follows.

First, install resistors R1, R5 & R6 and diode D1, followed by the 0.1µF capacitor. Next, insert and solder the 8-pin socket for IC1. Then install the other resistors and the LEDs for the mode you want, making sure the LEDs all go in the right way. The anode of the LED connects to the positive labelled hole on the board.

Next, solder in the pushbutton switch and piezo buzzer.

You will be supplied with a 4-AA cell battery holder but only three cells are required for the 4.5V supply. All the cells are wired in series in the holder so you need to solder a wire to short out one cell position.

Take care when doing this job otherwise you will melt and distort the battery holder. Then wire the battery holder to the appropriate terminals on the PC board.

Insert the PIC processor into its socket, making sure that you install it the right way around. Then insert the three AA cells into the battery holder and you should be up and running.

If it doesn't work as it should, you most probably have missed a solder connection or one (or more) of the LEDs is the wrong way around.

Finally, if you're prepared to add a rotary switch, you could arrange to make most of the modes available to play at will.

Where do you get it?

LED FUN is available as kit of parts from all Dick Smith Electronics stores at just $14.95 (K-3167). **SC**

Parts List

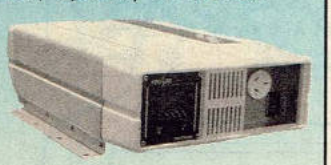
- 1 PC board, 68 x 34mm
- 1 PIC12C508 programmed microcontroller (IC1)
- 12 red LEDs
- 1 1N4148, 1N914 diode (D1)
- 3 2.2kΩ 0.25W resistors
- 3 270Ω 0.25W resistors
- 1 0.1µF ceramic or monolithic capacitor
- 1 pushbutton switch (S1)
- 1 piezo buzzer
- 1 4 AA-cell holder
- 3 AA cells

Note: see Table 1 for resistors and LEDs to be installed

Inverters what are they?

What's in it for you?

Inverters have matured very quickly in the last two years. Technology was forced forward to meet the demands of an aware market (people).



STATPOWER The largest global manufacturer of inverters and chargers have released the 1998 models.

NEW! Really, NEW technology, features and benefits!

Call us now for your nearest Dealer. Australia wide.

STATPOWER AUSTRALIA

Simply Brilliant Technology

BAINBRIDGE TECHNOLOGIES PTY LTD
77 Shore Street, Cleveland Brisbane Qld 4163
PH: (07) 3821 3333 Fax: (07) 3821 3977
Email: baintech@powerup.com.au Internet: www.statpower.com

Protect Your Valuable Issues

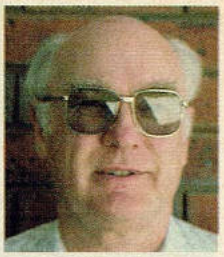
- Heavy board covers with 2-tone green vinyl covering
- Each binder holds up to 14 issues
- SILICON CHIP logo printed in gold-coloured lettering on spine & cover

Price: $A12.95 plus $A5 p&p each (Aust. only).

Just fill in & mail the handy order form in this issue; or fax (02) 9979 6503; or ring (02) 9979 5644 & quote your credit card number.

VINTAGE RADIO

By RODNEY CHAMPNESS, VK3UG



A piece of 1920s history: the Atwater Kent Model 32

The Atwater Kent is a very collectable 7-valve TRF receiver from the mid 1920s. It's a simple set but boasted some interesting technical features, as we shall see.

It's not often that anyone gets a chance to work on one of these classic sets from the 1920s. A friend who was looking after a deceased estate asked if I would check the set out to ensure it was in good order. By doing this, it was hoped that a better price would be achieved when it was sold.

As might be expected, I jumped at the chance to get my paws on such a receiver.

The previous owner had apparently overhauled the set quite some time before and it was reputed to be in working order. However, my friend wasn't prepared to take a punt on this, hence my involvement.

These old Atwater Kent radios are a joy to behold and feature an attractive polished wooden cabinet, single control tuning and four tuned RF stages. The tuning capacitors are beautifully made and are coupled together by flexible metal bands to provide the single knob tuning. Getting that lot to track could be a problem, as described later in the article.

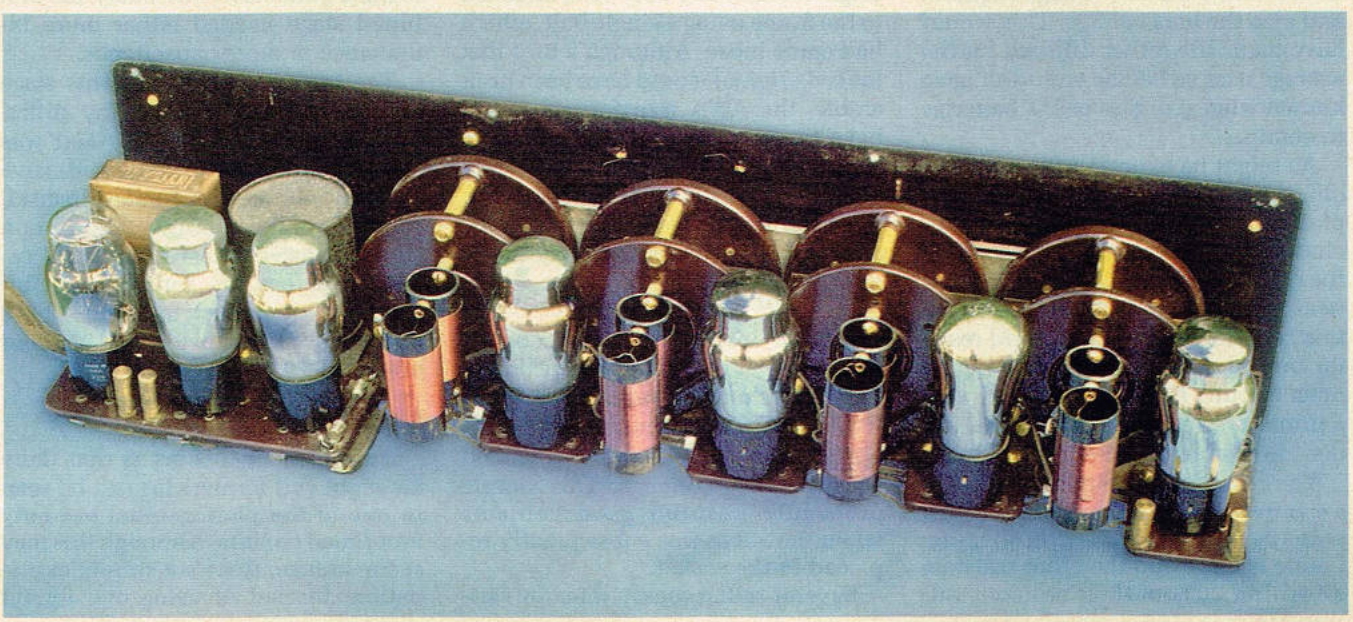
Twin-filament rheostats and an on/off switch completed the range of controls.

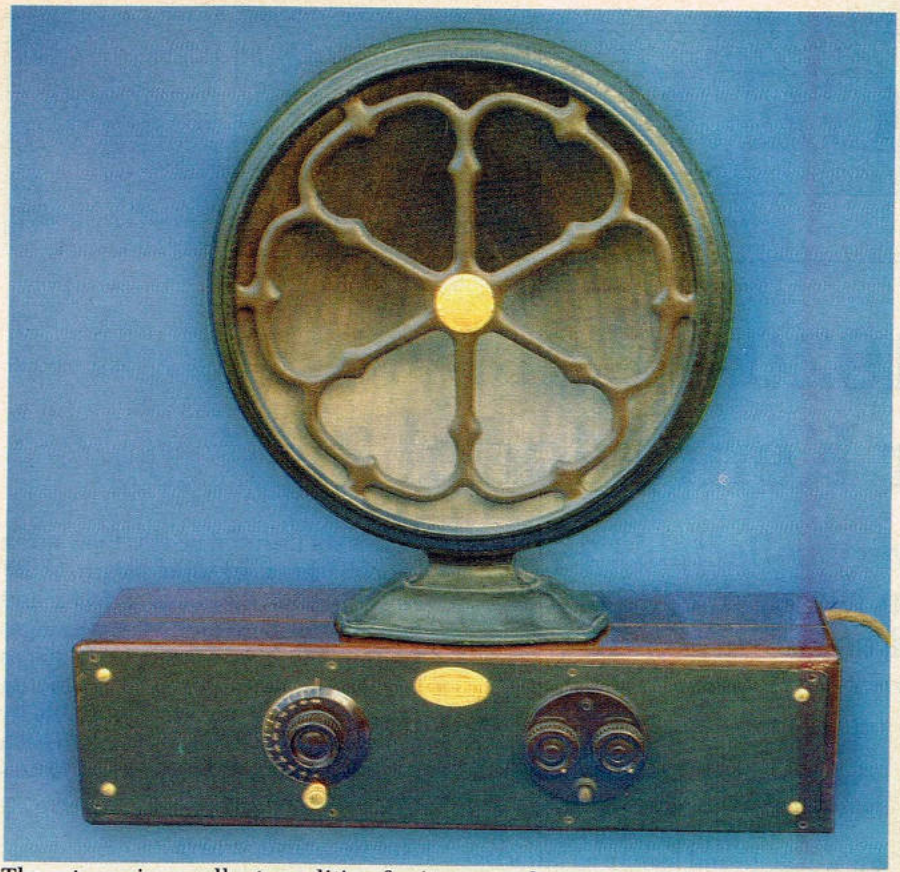
This set featured no less than seven valves. There are four stages of RF amplification, a grid leak detector and two transformer-coupled audio stages feeding the loudspeaker. All stages are triodes, with no neutralisation on the RF stages. They are kept stable by the use of a resistor in series with each RF stage grid and because the valves had such low gain.

Restoration work

Some of the 01A (or 201A) valves now fitted to the set were higher than those originally supplied, so the valves were withdrawn before the chassis was removed from the cabinet. I didn't want to knock the top off the valves as

BELOW: the chassis is easy to work on, with all parts readily accessible. Only one part (a 3MΩ resistor) proved to be defective.





The set was in excellent condition for its age and came complete with an E-model Atwater Kent loudspeaker.

they are rather hard to replace these days. The audio output valve in this set is a 71A which is a triode with a gain of three (wow). It can require upwards of -40V of bias too.

The instructions with the set said to consult the valve manufacturer's data if you changed the output valve, to determine the HT voltage required and also the bias voltage. This would have made life rather difficult for the average user as he/she wouldn't have known what size bias or HT batteries to obtain.

As might be expected for a set this old, quite a few parts had been replaced over the years. These parts included the valves and a couple of fixed components. The only component that proved to be defective on this occasion was the 3MΩ grid resistor on the detector, which had gone open circuit. This was replaced with a miniature resistor, which I hid under the filament centre-tap resistor.

The remaining components in this set proved to be in very good order, with the capacitors showing no measurable leakage and the other resistors all within 20% of their nominal values. The circuit diagram that I obtained had a number of errors in the component values used. The circuit diagram (with corrections) is shown in Fig.1.

The second audio transformer had been replaced with an AWA 3.5:1 ratio unit. Quite obviously, it wasn't original and it had only been attached to the frame using a single bolt, which had come loose. Although a unit that looked original would have been preferable, the AWA transformer would have to do. It was remounted using two machine screws, nuts and washers and the wiring to it tidied up. This remedial work greatly improved the appearance of the replacement unit.

Valve socket corrosion

Further inspection of the chassis revealed that the metal wipers on the socket of the 71A valve were black from corrosion. To fix this, the valve was removed and the corrosion sanded off the socket contacts. This simple procedure ensured good contacts when the valve was subsequently replaced in the socket.

Several rather messy joins in various cables were also tidied up and sheathed with new insulation. The individual leads in the battery cable were then identified and fitted with white plastic tape markers. The function of each wire was noted using a marker pen, so that they could later be easily identified.

The moment of truth

Before applying power, I did a final check of both audio transformers and the general wiring but could find nothing else that might be amiss. I am always very cautious with such old sets, as the valves, in particular, are very hard to replace.

The Atwater Kent required several supply rails, as follows: A = 5-6V; B = 22.5V and 67.5V; and -9V for the C bias. By the way, the 71A triode can be used with a B+ voltage of up to 180V but this would require -40V of bias. Finally, an aerial and earth were connected and it was time for the big test.

With the power applied, the valves lit up nicely and I was able to tune in quite a few stations across the band. Here in Benalla (Victoria), a total of 15 stations were audible in daylight but not all were of "entertainment quality". I wondered how well the tuning tracked with four tuned stages and decided to carry out a couple of experiments.

First, I found a small ferrite rod and slid it into each of the eight coil formers to assess what the tracking was like on various parts of the band. All except the first tuned circuit appeared to track quite well. Obviously, the first tuned stage needed either more inductance or more capacitance.

The tuning capacitor in this stage did not appear to mesh any differently to the others, so no point was seen in fiddling with the ganged-drive system to correct the problem. Instead, some careful experimentation soon showed that connecting a 6.8pF capacitor across the tuning capacitor gave almost perfect tracking. That's not bad for a set made in 1926 and now over 70 years old.

Eight coil formers

An oddity of this set is that there are eight coil formers (as can be seen in one of the photographs) but only four tuned circuits. Although this may seem strange, there's a simple explanation. Instead of using one former

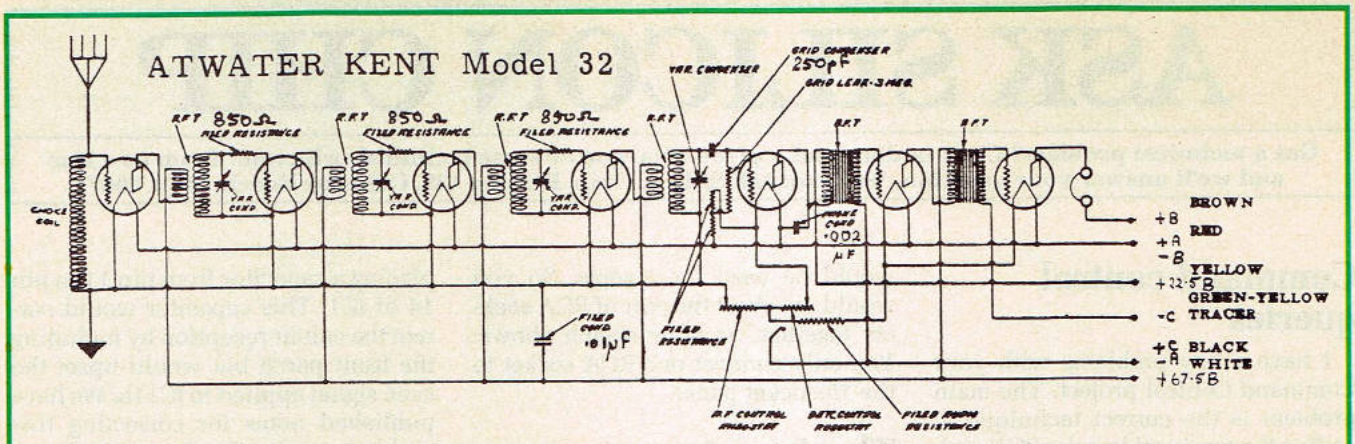


Fig.1: the Atwater Kent is a TRF receiver with seven triode valves and four tuned stages.

for each tuned circuit, the Atwater Kent uses two coil formers with series wound coils. The plate winding for each stage is mounted inside one of the coils. I have no idea why they did that, as it seems like extra work to me.

By the way, the set came complete with an Atwater Kent E-model speaker and – would you believe it? – the original installation and operations manual (see photos).

Summary

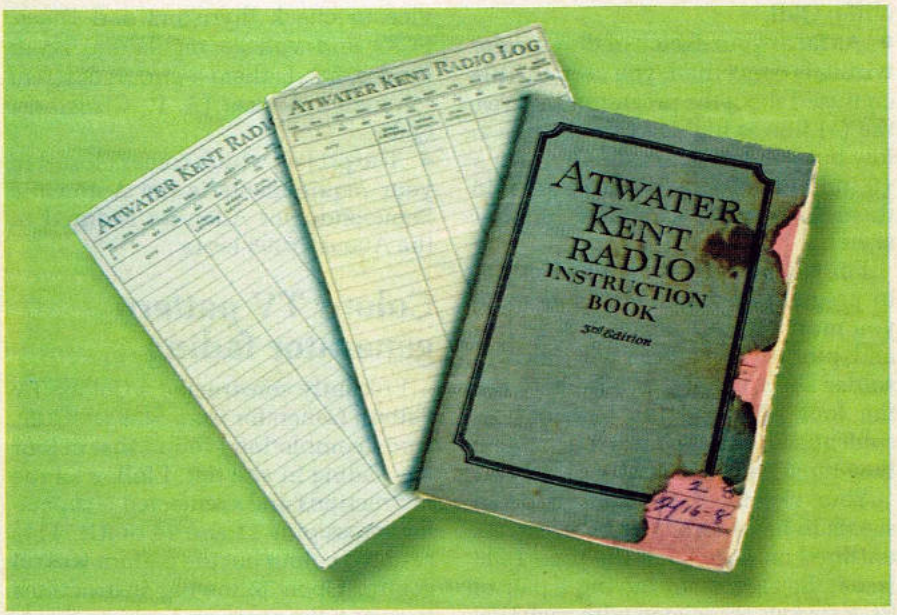
As can be seen from the circuit diagram, the set is remarkably simple (like most of that era). It doesn't use neutralisation as other manufacturers had the patent on that, so each triode stage had to be made stable in its own right. This was done by using series grid resistors and low gain triodes.

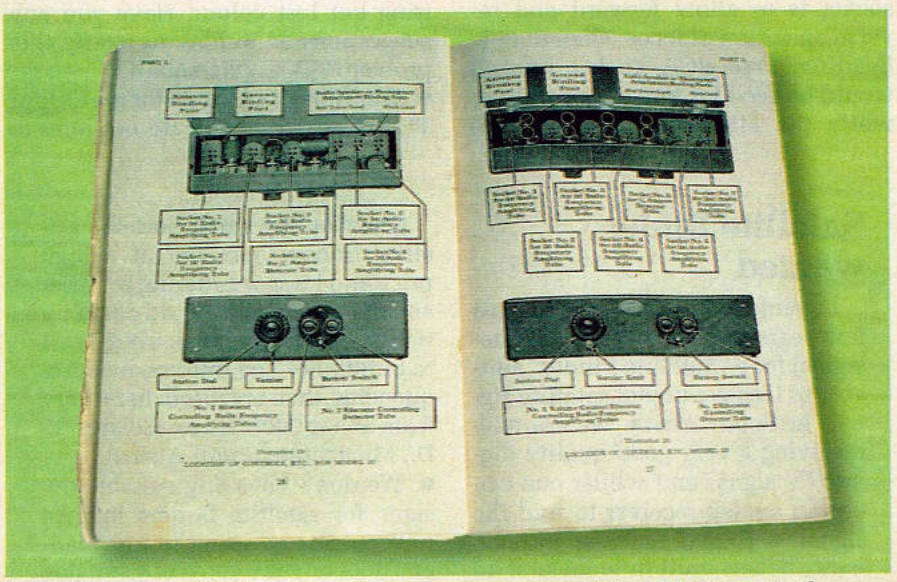
The set uses four single-gang tuning capacitors which are ganged together using flexible metal bands. Its tracking is remarkably good, even without any trimming capacitors. The set is stable, uses good quality components throughout, is visually appealing and works well for its type. Neutralised triodes would have been better performers but if you can't use them due to patent problems, you just do your best.

Performance

Finally, the set's performance could be compared to the Astor "football" of the 1940s. This set used two valves in a TRF circuit with reflexing. They are both classics of their individual types and eras.

All in all, the old Atwater Kent is a very collectable set and I understand that it now has a new home. **SC**





The old Atwater Kent radio receiver even came complete with its original instruction manual. It's rare to find a receiver like that after all this time.

ASK SILICON CHIP

Got a technical problem? Can't understand a piece of jargon or some technical principle? Drop us a line and we'll answer your question. Write to: Ask Silicon Chip, PO Box 139, Collaroy Beach, NSW 2097.

Command control queries

I have a few problems with your Command Control project. The main problem is the correct technique of coding the receiver/decoder PC board. Since I've never done anything like this before, I would like to be sure the first time. Please help. (L. F., Shorncliffe, Qld).

● As far as your sketch of the encoder wiring is concerned, you seem a little confused about the programming. Yes, the (+) line is high and the (-) line is low but you must link pins 1, 9, 10 & 15 individually high or low, not join them all together as shown on your sketch.

For example, as shown in Table 1, to program for channel 2 operation, you must connect pins 1, 9 & 10 low and pin 15 high. You will need to solder short lengths of wire between the four pins and the high or low solder pads. You can't just touch them; they must be permanently soldered.

Your sketch of the control panel seems to have a number of errors. As outlined on page 85 of the June 1998 issue, the reason for having a pair of RCA sockets associated with each DIN socket is to allow forward and reverse operation of locos when double heading. One RCA socket (white) would be used for forward operation, while the other RCA socket (red) would be used for reverse. So you would not short the pair of RCA sockets together, as your sketch shows. You only connect one RCA socket to the 16-socket panel.

Thyristor & diac tester

Could you tell me if there is a device to check thyristors and Diacs, SCRs and voltage regulators, zener diodes, etc. Is there a circuit diagram for such a device? (A. P., Gladstone, Qld).

● The project which comes closest to your requirements is the Automatic Semiconductor Analyser featured in the August 1998 issue

Colour TV pattern generator fading

I recently constructed a Colour TV Pattern Generator from SILICON CHIP. Upon completion I found that colour was fading in and out. I followed the instructions and connected a capacitor across pins 11 and 14 of IC1. This restored colour but the pattern was off centre. Upon following instructions to correct the centring, I achieved centring but lost colour. Have you any suggestions as to how to rectify this problem? (B. C., via email).

● Our Notes and Errata for the Colour TV Pattern Generator do not refer to placing a capacitor from pin 11 to pin 14 of IC1. This capacitor would correct the colour reception by including the front porch but would upset the sync signal applied to IC11b. We have published notes for correcting this problem in the October 1997 issue. Note that you may need to increase or decrease the value of the 270pF capacitor for satisfactory results.

Satellite finder wanted

I wonder if perhaps over the last few years you have any circuit designed for a "Satellite Finder" suitable to locate a digital satellite signal. In South Africa, we are now receiving a very good quality digital TV signal and whilst one can use an analog receiver to find the signal, a digital receiver has too many delays built in to make it an easy task.

One can buy small portable satellite finders here but at a high price and I was wondering whether any of your experts could come up with a simple, inexpensive circuit to build one. The intermediate frequencies that are used here vary from about 900MHz to 2.2GHz. (E. D., Mmabatho, South Africa).

● We don't have any suitable designs for satellite finders but we will put the question to our readers: does anyone know of a suitable design?

Circuit wanted for quartz clock

Could you please give the test procedure and circuit diagram for a quartz analog clock. The one I have is a bit "upmarket" from the cheap plastic units in electronics stores, being nearly all brass. (G. R., Ashfield, NSW).

● In our experience, the quartz movements used in upmarket clocks are exactly the same as used in the cheaper clocks. The only article we have published which is relevant was entitled "A Fast Clock for Railway Modellers" in the December 1996 issue. That article did show the circuit of a typical clock module. We can supply back issues at $7 including postage.

Command control for slot cars

I read with interest your articles on Command Control for Model Railways. Can you see any problem with using this system to run a number of Scalextric Slot Cars on each lane? These run on 12V DC and draw no more than 1A. They are scale 1:32 models and should accommodate the decoder without a problem. Being primarily a model car enthusiast and a new recruit to electronics, I'm afraid I might be missing some glaring reason why this idea wouldn't work. (P. H., Mudgeeraba, Qld).

● In principle, Command Control should work with Scalextric slot cars although we have not heard of anyone doing it. We would be wary about the amount of hash that would be present on the common supply rail and this

8-channel remote for outdoor use

I am writing in regards to the 8-channel IR remote control unit published in the February 1996 issue of SILICON CHIP. I am trying to design a mechanised target pulling system for our local rifle club. It consists of a programmable timer (BASIC Stamp), a transmitter, receiver and a wiper motor to drive the targets. We shoot at two ranges, 25 and 50 metres. As all the action is to be controlled by the range officer (standing behind the shooters), a cordless system would be ideal.

What I need to know is will this IR remote control work at a distance of 50 (or so) metres in outdoor daylight? If not can the unit be modified to do so? I've seen similar IR remote control devices for overhead cranes in factories, with a range of about 60 metres (indoors).

Obviously the other option is a UHF transmitter. However I have been right through the project list on your web-site and can't find any UHF transmitter with the minimum of four channels and range I need.

I would also like to try avoid using a solid wire cable as we are currently running out ropes and using a separate person to pull the targets. Running out wire cables seems to defeat the purpose. Permanent wire cable would be better but would need connectors on each end (as all equipment must be removed after the shoot), all of which would be exposed to the weather, and unfortunately as the security is poor, to vandals as well. (L. T., Sawtell, NSW).

● Infrared will not work in sunlight. We suggest that you use the 8-channel encoder and decoder circuitry described in February 1996, together with the UHF transmitter and receiver boards in the same issue. It's that easy and it will have the range you want.

could possibly cause problems with decoder operation.

Bigger sparks from ignition system

I refer to the Multi-Spark Capacitor Discharge Ignition system in the September 1997 issue of SILICON CHIP and to a recent article I saw in "Electronics World", confirming what I require and that is a bigger and higher energy spark! This article states that a minimum 150mJ-250mJ spark is required for most efficient combustion. I assume a 250mJ spark is approaching a desirable spark energy level.

Your article quotes the spark energy of your CDI at 45mJ. I assume that that would be the energy (ie, $\frac{1}{2}CV^2$) in C2 for one spark. What is the energy at the spark plug after coil losses or are coil losses negligible?

The improvement I'd like to see is a spark energy of over 150mJ/spark at the spark plug, so that if the device is set at only two sparks, one would still get well over 250mJ of total spark energy. Normal running rpm for a 4-cylinder or a 6-cylinder engine with your device is only four sparks per firing or 4 x 45 = 180mJ (assuming no coil losses) and is only just over the 150mJ lower limit of the other article. Why skimp on spark energy when your device probably draws less current than one headlight on low beam?

As I see it, the easy avenues to increase spark energy are: (1) increase the 300V supply (tempting because of the V^2 improvement). However, for the present circuit, the maximum easy increase would probably be only about 50V (ie, add a 50V zener) before requiring numerous other changes to the high voltage power supply. Can I add an extra zener diode without causing circuit problems? (2) Increase C2 to about 4µF. Very easy to do but what other modifications would be required for best results?

Assuming I increase C2 to 4µF, what other changes would be required? Increase the 275VAC power supply capacitor? Increase IC1's oscillation frequency from 22kHz? I note that SILICON CHIP is associated with "ZOOM" magazine. With the assistance of ZOOM why not test the veracity of the claims in the "Electronics World" article and do dyno, exhaust gas readings, economy, etc but use your CDI system? I have read claims that with a really big spark (perhaps 1000mJ) you can run an engine on diesel or kerosene and at extremely lean mixtures.

I believe car engine management systems would be largely unnecessary if engines had a decent big spark. (J. W., Carrara, Qld).

● We're not keen on increasing the spark energy from the Multi-Spark CDI because we think it already has more than enough for normal cars. But we'll tell you how it can be done and then we'll tell you why it shouldn't be done.

First, as you suggest, you can increase the DC voltage from the inverter to 350V, merely by adding another 50V zener diode. The inverter should be able to deliver the higher voltage over most of the range but it might tend to droop a bit at very high spark rates.

Second, we have made provision for a second 1µF dump capacitor on the PC board so all you need do is to add it in. Those two modifications will increase the nominal spark energy, per spark, from 45 millijoules to 122.5mJ. The formula to work out the spark energy is given by:

$$E \text{ (joules)} = \frac{1}{2}CV^2$$

where V is the voltage and C is the capacitance in Farads.

By increasing the spark energy to 122.5mJ, with four sparks per firing, the total energy per firing, is 490mJ or almost half a Joule. For virtually all running on a 4 or 6-cylinder engine you will have at least six sparks each time a cylinder fires, and this adds up to a total spark energy of 270mJ with the system as we described it, so we see little reason to change.

We can't answer your question about coil losses in any detail. We assume that the losses in older designs of ignition coil would be quite high since the magnetic circuit is not closed. More recent ignition coils are much smaller and have a closed magnetic circuit and so the losses should be much less but in these cases, we're talking about cars which have electronic ignition anyway.

Now we'll give the reasons why the design should be left as we described it. First, there will inevitably be more voltage stress on the circuitry and that will ultimately reduce its reliability. Second, you will put a lot more stress on the ignition coil and the spark plug leads and this really will reduce the reliability, especially as far as the coil is concerned. Push an ignition coil too hard and it will break down inter-

Tacho for motorcycle

I have built a digital tachometer from the August 1991 issue. I hope you may be able to help me with it. On my car it works fine, so its construction is OK but I bought it to run on a motorcycle which is a twin cylinder with a 90° crankshaft. I tried running it just off one cylinder as the ignition is independent on each cylinder (separate triggers and coils) but even with more resistors at "RX" it doesn't work well. I tried using diodes and triggering it off both cylinders but they fire unevenly and it would read say 900 RPM, then 1300 RPM alternately.

The bike uses an alternator with permanent magnets (I think). Can you tell me how to alter the tacho to trigger from the alternator? Some outboard motors drive their tachos that way, picking up the AC before it's rectified. My son and I have built up a motorcycle each from their 90° crankshafts to the carbon fibre body work, exhausts, ignitions, etc. We would like to run the digital tachos on them, if we can, as we enjoy constructing things. (M. P., Kalaru, NSW).

● You could trigger the tachometer from your alternator windings. However, you need to obtain the signal before the diodes rectify to DC and only tap from one winding of the alternator unless you use separate diodes to isolate each winding.

The input circuit for the Digital Tachometer will need to be altered so that it is more sensitive. This should only require the 33kΩ resistor which is normally required to connect to the ignition coil to be changed to a 1kΩ value. You may find that the .022µF capacitor in series with this resistor and connecting to the base of Q1 may need to be shorted out with a wire link for best results.

nally. This only has to happen a few times and then the coil will fail every time it is called upon to deliver high plug voltages and this always occurs when the engine is under heavy load.

While it might be OK to push the system to its limits for a drag car, for example, we don't like the idea of the ignition coil in a road car being more highly stressed, especially if it is an older car anyway.

Second, because you will be applying higher voltage and higher energy to the ignition system, there is considerably more chance of crossfire and this could easily lead to engine failure.

Third, applying more spark energy will lead to faster erosion of the spark plug gap. This will open up the gap faster, leading to high plug voltages, and again the risk of breakdown in the coil and in the ignition leads. Once they break over a few times, they've had it. Some modern cars with high energy ignition system already use platinum-tipped plugs to reduce the effects of electrode erosion.

Yes, some engines can run on diesel or even kerosene. They are called diesel engines. Any scheme for running a conventional petrol engine with huge spark and diesel fuel is ratbag fringe stuff.

And no, we don't agree at all with your belief that engine management systems would be unnecessary if engines had a decent spark. Engine management systems work so well because they deliver the right mixture at the right time under all load conditions and then they deliver a good spark at exactly the right time. A good spark is only a small part of the formula for good engine performance.

Mixer output impedance

Is it possible to let me know the output impedance from the main outputs on your 8-Channel Stereo Mixer (November/December 1996)? I guess it is determined by the LM833 op amps. This is an important parameter to know when using long cables. (R. H., Mullumbimby, NSW).

● The source impedance of the main outputs will be very low, less than 100Ω, due to the use of op amps with a large amount of negative feedback. However, for best performance the load impedance should be 4.7kΩ or more.

Core for battery charger

I have a question about the Auto 10A Battery Charger published in the June 1996 issue of SILICON CHIP. I recently bought an incomplete kit on special, thinking both cores were present. Unfortunately I only found the core for L1 when I got home.

Since then I have been hunting for a replacement core for T1. The article does not specify the make or type number (as it does for L1). Could you give me the specs for the core please? Also a suggestion where to get it would be appreciated since I cannot locate anyone who sells ferrite E cores. I've tried Radio Spares, GEC Electronics and all the smaller shops like Tandy, etc.

I do have a ferrite core wound transformer from an old monitor which will fit but I think it only has 66 windings, rather than the 100 you specify, and the wire is much thicker. I think its ratio is 1:1 but I can't test it. How sensitive is the circuit to the wire size, turns and turns ratio on T1? (P. J., via email).

● T1 was a Jaycar LF-1270, which is not listed in the current catalog. We have no information on it although we believe it was a Siemens core. Farnell (http://www.farnell.com) list Siemens EFD25 series 1/2 Core P/N 200-300, Bobbin P/N 200-311, Clip P/N 200-323.

These should be OK even if not exact replacements. T1's wire size is not critical but the turns ratio is!

Increasing the 12V charger output current

I have built the 12V "floating" battery charger as in the October 1998 issue. It works well but I have a couple of questions:

(1) Can the charger be uprated to 4A and if so what components need to be changed? (I know the transformer does);

(2) I have an ammeter fitted to the unit. Is there a way that this could be connected to give the output current to the battery? I do realise that Rs removes the base drive to Q1 if the current exceeds 2A.

One problem does exist: if the revised circuit works when I build it, great; if not, I don't have the equipment to see what's going on and there-

fore repair any faults in the circuit. (G.W., Braddon, ACT).

● Quite a few components would need to be changed to make the circuit capable of delivering 4A. You would need to change the transformer, bridge rectifier, the sensing resistor (halve it) and the transistor heatsink needs to be at least twice as large.

Frankly, we're not keen on the idea, especially if you're not confident about troubleshooting the circuit if it doesn't work first time.

Damaged speed controller killed the IGBT

We have built one of the 240VAC speed controllers from the November 1997 issue to drive a new 2hp Hitachi router. The unit tested brilliantly with incandescent bulb and electric drill. We then tried it on the above router and excellent results even when "hogging" into timber with a 12mm cutter. So to the real reason we built the controller: we needed a small special purpose centrifuge and on the cheap. Essentially, the same router is mounted as for a router table with a carefully balanced "pot" weighing 50g mounted in the collet.

The router is run slowly up to about 8000 rpm over about one minute, held at that speed for two minutes, then switched off. The cycle is repeated after about five minutes. So the router is not working under any appreciable load. We completed 10 cycles and then switched the lot off. Next day when we went to repeat the process the unit would only run at full speed and tests show that the IGBT is low resistance across source and drain. The DC supply is also down to about 5V but I guess this is because there is an appreciable current through the IGBT to ground. The 4050 gets hot and removing it puts the DC back up to 15V.

The unit and the router have done only about four hours work in total; the brushes appear new, as does the armature. There has been no breakdown of the insulation between box and IGBT. The kit was supplied by Jaycar but I am not sure if the IGBT is a genuine Siemens and at $39 a shot, it's not cheap. As we only want to run up to about 10,000 rpm, could the gate current be limited? How heat sensitive is the IGBT? The unit was warm to touch but it seemed well within usual limits. Would adding a heatsink and/or fan help? Sorry about the long and involved story but do you have any suggestions? (I. S., via email).

● The IGBT is well heatsinked with the diecast case and is operating well within its ratings even at 10A. Failure of the device is most likely due to an accumulation of heavy transient current or excessive voltage across it from inductive loads. It would be prudent to check the MOV (MOV1), the fast recovery diode (D1) and the snubber components (82Ω resistor and the .01µF 250VAC capacitor) which are mounted across Q1.

Note that poor solder connections around any of these critical components could cause the IGBT to fail because if any one of these is open circuit while the unit is working, the IGBT has no protection at all.

We've also heard of one user assembling this unit with "high tin" solder. This invariably causes cold solder joints or, if the soldering iron is hot enough, it can cause damage to the components. Needless to say, his controller stopped working while powered up although luckily no serious damage was done.

The BUP213 IGBT will have a Siemens logo on it if it is a genuine component. The Siemens logo is a large S which is sloped anti-clockwise by about 45°. At the centre of the S is a H sloped with the same angle.

We suspect that the 4050 (IC2), and the 15V zener (ZD2) are also faulty and should be replaced along with the BUP213.

Increasing the value of the gate resistor for Q1 will improve its short circuit rating but at the expense of increased dissipation due to slower turn on and turn off times. The 10Ω resistor could, however, be increased to 47Ω without any undue effect on its temperature rise. Gate current limiting will not limit the router speed. You would need a tachometric circuit to achieve that.

Interface card draws high current

I built the "Flexible Interface Card For PCs" as described in the July 1997 edition. Could you tell me what current it should draw from the +5V line? It seems to be drawing about half an amp and is burning out the power supply we have. (J. A., via email).

● The current drain from the 5V rail should be quite modest, no more than 50-100mA at a guess; nothing like 0.5A. You have a fault there somewhere.

Notes & Errata

Turbo Timer, November 1998: The 100µF capacitor shown connected to pin 6 of IC1 on Fig.2 (page 27) should be 220µF to agree with the circuit diagram on page 26.

WARNING!

SILICON CHIP magazine regularly describes projects which employ a mains power supply or produce high voltage. All such projects should be considered dangerous or even lethal if not used safely. Readers are warned that high voltage wiring should be carried out according to the instructions in the articles. When working on these projects use extreme care to ensure that you do not accidentally come into contact with mains AC voltages or high voltage DC. If you are not confident about working with projects employing mains voltages or other high voltages, you are advised not to attempt work on them. Silicon Chip Publications Pty Ltd disclaims any liability for damages should anyone be killed or injured while working on a project or circuit described in any issue of SILICON CHIP magazine. Devices or circuits described in SILICON CHIP may be covered by patents. SILICON CHIP disclaims any liability for the infringement of such patents by the manufacturing or selling of any such equipment. SILICON CHIP also disclaims any liability for projects which are used in such a way as to infringe relevant government regulations and by-laws.

Advertisers are warned that they are responsible for the content of all advertisements and that they must conform to the Trade Practices Act 1974 or as subsequently amended and to any governmental regulations which are applicable.

MARKET CENTRE

Cash in your surplus gear. Advertise it here in Silicon Chip.

CLASSIFIED ADVERTISING RATES

Advertising rates for this page: Classified ads: $10.00 for up to 12 words plus 50 cents for each additional word. Display ads (casual rate): $25 per column centimetre (Max. 10cm). Closing date: five weeks prior to month of sale.

To run your classified ad, print it clearly in the space below or on a separate sheet of paper, fill out the form & send it with your cheque or credit card details to: Silicon Chip Classifieds, PO Box 139, Collaroy, NSW 2097. Or fax the details to (02) 9979 6503.

_____ _____ _____ _____ _____

_____ _____ _____ _____ _____

_____ _____ _____ _____ _____

_____ _____ _____ _____ _____

_____ _____ _____ _____ _____

_____ _____ _____ _____ _____

_____ _____ _____ _____ _____

_____ _____ _____ _____ _____

_____ _____ _____ _____ _____

_____ _____ _____ _____ _____

Enclosed is my cheque/money order for $_____ or please debit my

☐ Bankcard ☐ Visa Card ☐ Master Card

Card No. | | | | | | | | | | | | | | | | |

Signature_____ Card expiry date_____/_____

Name _____

Street _____

Suburb/town _____ Postcode_____

FOR SALE

C COMPILERS: everything you need to develop C and ASM software for 68HC08, 6809, 68HC11, 68HC12, 68HC16, 8051/52, 8080/85, 8086 or 8096: $145.00 each. Macro Cross Assemblers and Disassemblers for above CPUs + 6800/01/03/05, 6502 and 68HC12 now combined at the new low price of $75. Debug monitors: $75 for 6 CPUs. All compilers, XASMs and monitors: $480. 8051/52 Simulator (fast, now incl. 80C320): $75. Try the C-FLEA Virtual Machine for small CPUs, build a "C-Stamp". Demo desk: FREE. All prices + $5 p&p. **Atmel Flash CPU Programmer:** Handles the 89Cx051, the 89C5x and 89Sxx series, and the new AVRs in both DIP and PLCC44. Also does most 8-pin EEPROMs. Includes socket for serial ISP cable. $199, $37 tax, $10 p&p. SOIC adaptors: 20-pin $90, 14-pin $85, 8-pin $80. Credit cards accepted. GRANTRONICS PTY LTD, PO Box 275, Wentworthville 2145. Ph (02) 9896 7150 or Internet: http://www.grantronics.com.au

SPEAKERWORKS: specialist in speaker repairs and parts. DIY refoam kits: 3½", 4", 5", 6", 7", 8", 9", 10", 11", 12" and 15" $39.95. Includes shims, dustcaps and adhesive. Largest inventory of cones, surrounds, gaskets, spiders, dustcaps, grilles, foam and cloth and 4,700 custom voice coils. Phone 02 9420 8121, Fax 9420 8131.

WEATHER STATIONS: Windspeed & direction, inside temperature, outside temperature & windchill. Records highs & lows with time and date as they occur. $420.00 complete plus sales tax if applicable. Optional rainfall and PC interface. Used by Government Departments, farmers, pilots, and weather enthusiasts. Other models with barometric pressure, humidity, dew point, solar radiation, UV, leaf wetness, etc., etc. Just phone, fax or write for our FREE catalogue and price list. Solar Flair/Ecowatch ph: (03) 5968 4863 fax: (03) 5968 5810, PO Box

18, Emerald, Vic., 3782. ACN 006 399 480.

*****TOP QUALITY VIDEO CAMERAS***** UP TO 730 DAYS WARRANTY * Hi-Res SILICON CCD MODULES only $59 ** PREMIUM SONY H.A.D. CCD & CHIPSET 480 + Line x 0.05 Lux 32 x 32 MODULES from $91 ** CAMERAS: Mini 36 x 36 from $88! Dome from $91! COLOUR DIGITAL SIGNAL PROCESSING CAMERAS & MODULES: 400 + Line from $180! DOME from $185! 480 + Line DOME with SONY CCD from $246! 600 + Line from $346! OUR CAMERAS & QUADS PRODUCE "NEAR SUPER-VHS" TO "BETTER THAN SUPER-VHS" QUALITY IMAGES. ACCESSORIES: 30 + Lenses 2.1 to 16mm. FILTERS: Polarising, Colour, Temp-Conv, Infra-Red Cut & Pass for Image Enhancement, Colour Correction, Focus, Glare & Exposure Control. 50 LED DIY Infra-Red Illuminators only $19! ANCILLARY EQUIPMENT: QUADS 4 pix 1 screen from $280. *** COLOUR QUAD Hi-Res 720 x 576 2-PAGE 8-Camera with Time/Date Generator from $749! ** PACKAGED SETS! QUAD + 4 CAMERAS + Power Supplies from $689 ** SWITCHER + FOUR CAMERAS + REG Power Supply from $508! MULTIPLEXERS FULL-SCREEN FULL-RESOLUTION VCR Recording/Playback from $826! SWITCHERS 4 & 8 Ch from $126! ALSO: Monitors, Outdoor Housings, Brackets, Dummy Cams, CCTV-TV/VCR Interface Modules, Motorised Pan Units etc. CCTV Technical Reference Manual 400 + Pages $95 or FREE! DISCOUNTS: Based on ORDER VALUE, BUYING HISTORY, for CASH/CHEQUE & NZ BUYERS! BEFORE you BUY Ask for our Illustrated Catalogue/Price List with Application Notes & Special New Enquiry Offer. Allthings Sales & Services (allthings.com.au) Ph 08 9349 9413 Fax 08 9344 5905.

ELECTRONIC INSTRUMENTS: Oscilloscopes: Tektronix 7603 with timing base 7B53A (100MHz time delay) and two 7A26 price $1020; Tektronix 7603 with timing base 7B80 (500MHz), 7A16 and 7A18N modules $1350; BWD 525 50MHz two CH. $370; HP1740A 100MHz time delay two CH. $750; Rohde & Schwarz signal generator SMS 0.1-520MHz $1250; RF Wattmeter model 6154 Bird Corp. USA $90; Fluke 891A DC Differential Voltmeter $230; Fluke 893A AC-DC Differential Voltmeter $320; Digital Multimeter Fluke 8050A $280; Fluke 8022B $95; HP3465A $280; Sanwa CAM-270 Multimeter $95; Current Transformer CT-500 500A Testing & Certification Australia $90. Royel RE800-3 Soldering & Desoldering Station $450; Auto-Soldering Station SKY00MPO Apollo Seiko $700. **Tel/Fax: (03) 9309 3581 or 0412 340 692.**

CONTROL EQUIPMENT: PLC Control SIMATIC S5 SIEMENS Central Processing Unit 6ES5-103-8MA03 1 piece $500; EPROM 8K 6ES5-375-ILA15 1 piece $450; Digital Input Module 6ES5-421-8MA12 8x24V DC 6 pieces $60 each; Digital Output Module 6ES4-441-8MA11 8x24V DC/0.5A 11 pieces $60 each; Bus Module 6ES5 700-SMA11 10 pieces $50 each; Serial Interface Module 6ES5 521-8MA21 1 piece $350; Omron power supply 100-120/200-240V input voltage model S82K 05024 24V 2.1A output $150; E3X Omron Photoelectric Switch 2 pieces $90 each; TL-X2B1-GE Omron Proximity Switch 2 pieces $30 each; E32-DC200 Omron Photoelectric Switch 2 pieces $30 each. **Tel/Fax: (03) 9309 3581 or 0412 340 692.**

INTERNATIONAL SATELLITE TV RECEPTION in your home is now affordable. Send for your free info pack containing equipment catalog, satellite lists etc or call for appointment to view. We can display all satellites from 76.5F to 180F. AV-COMM P/L, 198 Condamine Street, Balgowlah NSW 2093. Tel: 02 9949 7417 or 9948 2667. Fax: 9949 7095; www.avcomm.com.au

---

A NEW address for Acetronics
http://www.acetronics.com.au
On-line PCB quotes, free software, DIY PCB supplies plus many other items & services. 02 9743 9235.

TELEPHONE EXCHANGE SIMULATOR, SC February 1998. Test equipment without the cost of telephone lines. $190. **MAGNETIC CARD READER,** SC January 1996. Holds up to 8 cards. Use as a door lock. $65. Melbourne 9806 0110.

KITS-R-US PO Box 314 Blackwood S.A. Ph/fax 08 8270 3175

FMTX2A Universal Stereo Coder $49
FMTX2B 30mW Xtal Locked 100MHz Transmitter $49
FMTX1 1-3 Watt Free Running Transmitter $49
FMX1 200mW Full Broadcast Transmitter, built & tested $499
FM220 10-18 Watt FM BGY133 Philips Linear $499
FM1525 25 Watt Discrete Linear FM Band $499
FM2100 110 Watt Discrete Linear FM Band $699
FM3000 300 Watt Discrete Linear FM Band $1499
Philips 828E/A VHF Receiver Boards (6 metres) $9
AWA 721 VHF Receiver Boards (2 metres) $9
AWA 721 VHF transmitter boards 1 watt (2 metres) $19
Philips 323 UHF transmitter boards 500mW (70cm) $19
AEM 35 Watt Little Brick Audio Power Amp $15
Digi-125 200W RMS Audio Power Amp $39
CA Clipper Compiler, new in box $49
6dBd Gain Colinear FM Band Antenna $999
Roll Smart-1 FM Station Audio Processor $999
Free catalog on disk of discounted surplus components
Same day shipping, credit cards OK, circuits supplied.

SPECIAL STEAM BOAT KITS $14

Need prototype PC boards?
We have the solutions – we print electronics! Four-day turnaround, less if urgent; Artwork from your own positive or file; Through hole plating; Prompt postal service; 29 years technical experience; Inexpensive; Superb quality.
Printed Electronics, 12A Aristoc Rd, Glen Waverley, Vic 3150.
Phone: (03) 9545 3722; Fax: (03) 9545 3561
Call Mike Lynch and check us out! We are the best for low cost, small runs.

Printed Circuit Board Manufacture
48-Hour service * High quality * Low prices
1 offs to any quantity
Artwork design if required
Call for obligation free quote...
INSTANT PCBs, POBox 448, Avalon 2107
Ph (02)9974 1189 Fax (02)9974 5491

fischertechnik
ROBOTIC KITS and interface units for computers. See silicon chip May 98 editorial or see web for pictures and free software:
http://www1.tpgi.com.au/users/p8king/
PROCON TECHNOLOGY
Ph: (03) 98306288 Fax: (03) 98306481
email: procon@tpgi.com.au Kits from $295

Positions At Jaycar
We are often looking for enthusiastic staff for positions in our retail stores and head office at Rhodes in Sydney. A genuine interest in electronics is a necessity. Phone 02 9743 5222 for current vacancies.

SPEAKERWORKS
Speakerworks stocks all the best Vifa Speaker Drivers. Call or fax for free kit designs.

	RRP	Our price
VIFA TC26SF-05-06 SHIELD.TWEETER	$59	$49
VIFA D27SG-15-06 SHIELD.TWEETER	$74	$59
VIFA D27TG-45-06 TWEETER	$69	$49
VIFA P13WH-00-08 WOOFER	$115	$79
VIFA M13SG-09-16 SHIELD.WOOFER	$85	$59
VIFA P17WJ-00-08 WOOFER	$98	$69
VIFA M22WR-09-08 SUBWOOFER	$179	$139

• Friendly advice • Prompt service
• Free data and plans
• Shipping $10 per order
• BC, MC, VISA welcome
vifa
Tel: [03] 9646 5115 Fax: [03] 9646 1574

Market Centre – continued

PICTUTOR: Programmer board + 32 tutorials for PIC84. Other models available. E.S.T. (02) 9789 3616. Fax (02) 9718 4762.

PCBS MADE, ONE OR MANY. Low prices, hobbyists welcome. Sesame Electronics (02) 9554 9760 sesame@internetezy.com.au http://members.tripod.com/~sesame_elec

1A LASER DIODE DRIVER, 3W head laser power monitor, IR laser diode with housing, greatly reduced price, e-mail lmatthee@perthpcug.org.au for details and pictures.

HOMEBUILT DYNAMO, engineering dreams into reality. "An absolutely marvellous book for the true experimentalist!" Elektor Electronics. (www.onekw.co.nz)

SOLAR PANELS: buy by mail and save! 75 watt from $590.00, unbreakable s/steel 64 watt $555.00. Largest manufactured: 120 watt $995.00, flexible 32 watt $475.00. Limited stock 22 watt $195.00. All other sizes available, top brands, lowest prices.
INVERTERS: budget inverters from $110.00 (12V 140W). High quality pure sine wave inverters from $390.00. Call with your requirements.
WIND GENERATORS: wide variety available, call with requirements.
TASMAN ENERGY Free call 1800 226626

RTN Australia Parallax distributor: Basic Stamps, SXKey development tools and SX chips. Wireless RF modules, serial LCD modules, Basic Stamp Bug, etc, etc. FerretTronics >R/C servo control chips. NEW: HandyScope 2 from Europe, 2-channel/12-bit portable measuring instrument, it's a voltmeter, digital storage CRO, transient recorder and spectrum analyser. All in a very small box powered off a parallel port. DOS and Windows software provided. Ph/Fax (03) 9338 3306. email: nollet@mail.enternet.com.au http://people.enternet.com.au/~nollet

RAIN BRAIN AND DIGI-TEMP KITS: 8 station sprinkler controllers, 60 channel temp monitor uses DS1820s over 500 metres. Has PC Data logging. **Mantis Micro Products,** http://www.home.aone.net.au/mantismp

WE PAY UP TO $60 for contributions to Circuit Notebook. Silicon Chip Publications, PO Box 139, Collaroy, 2097

KIT ASSEMBLY

ANY KITS assembled/calibrated: professional, speedy service. Phone Neville Walker (07) 3857 2752.

ANNOUNCEMENTS

DON'T MISS AUSTRALIA'S BIGGEST AND BEST EXHIBITION and sale of new and used radio and communication equipment at the Central Coast Field Day, Sunday 28th Feb, Wyong Race Course, just 1 hour north from Sydney. Starts 8.30 a.m. Special Field Day bargains from traders and tons of disposals gear in the flea market. Exhibits by clubs and groups with interests ranging from vintage radio, packet radio, scanning, amateur TV and satellite comms.
www.ccarc.org.au; Ph (02) 4340 2500.

HELP SAVE THE NIGHT SKY!

We are losing our heritage of starry night skies. Poor, inefficient outdoor lighting is causing glare and "light pollution". This wastes energy and increases greenhouse gas emissions.

You can help by joining SYDNEY OUTDOOR LIGHTING IMPROVEMENT SOCIETY (SOLIS). SOLIS aims to educate and inform about quality outdoor lighting and its benefits. We also lobby councils, government and other bodies to promote good lighting practice. SOLIS meetings are held third Monday night of each month at Sydney Observatory.

Individual membership is $20 pa. Donations are also welcome. Cheques payable to "SOLIS c/- NSAS", PO Box 214, West Ryde 2114.

Email: tpeters@pip.elm.mq.edu.au

Advertising Index

Altronics ..... IFC
Bainbridge Technologies 86
Dick Smith Electronics 14-17
Harbuch Electronics 53
Instant PCBs 95
Jaycar 45-52
Kalex 31
Kits-R-Us 95
Microgram Computers 3
Printed Electronics 95
Procon Technology 95
Quest Electronics 31
Scan Audio 83
Silicon Chip Back Issues 78-79
Silicon Chip Bookshop 65
Silicon Chip Subscriptions 33
Silicon Chip Binders/Wallcht . OBC
Solis 96
Speakerworks 95
Truscott's Electronic World 83
Zoom EFI Special ..... IBC

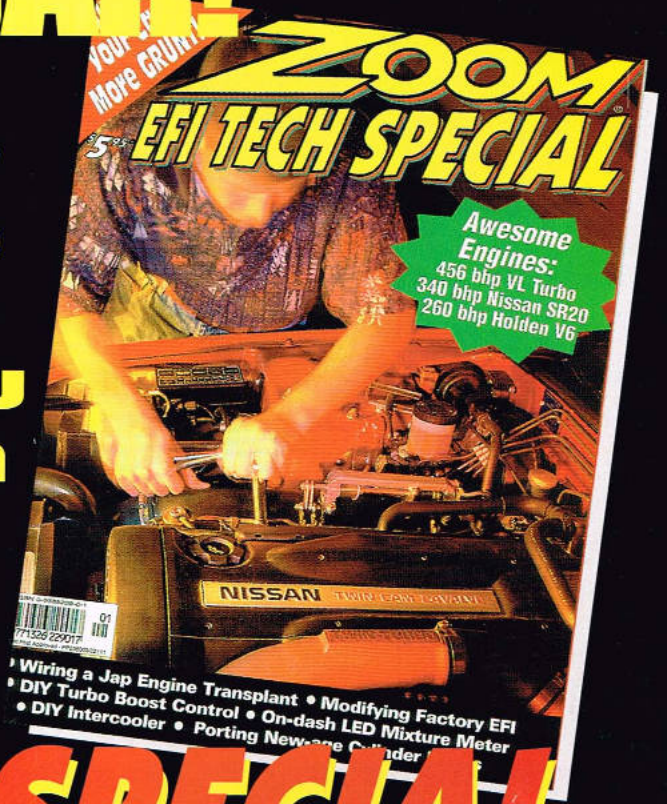
PC Boards

Printed circuit boards for SILICON CHIP projects are made by:

- RCS Radio Pty Ltd, 651 Forest Rd, Bexley, NSW 2207. Phone (02) 9587 3491.
- Marday Services, PO Box 19-189, Avondale, Auckland, NZ. Phone (09) 828 5730.

MORE FROM YOUR EFI CAR!

Own an EFI car? Want to get the best from it? You'll find all you need to know in this publication


ZOOM
EFI TECH SPECIAL
Awesome Engines:
456 bhp VL Turbo
340 bhp Nissan SR20
260 bhp Holden V6
NISSAN
Wiring a Jap Engine Transplant • Modifying Factory EFI
DIY Turbo Boost Control • On-dash LED Mixture Meter
DIY Intercooler • Porting New-age

EFI TECH SPECIAL

Here it is: a valuable collection of the best EFI features from *ZOOM* magazine, with all the tricks of the trade – and tricks the trade doesn't know! Plus loads of do-it-yourself information to save you real $$$$ as well . . .

HERE ARE JUST SOME OF THE CONTENTS . . .

- Making Your EFI Car Go Harder
- Building A Mixture Meter
- D-I-Y Head Jobs
- Fault Finding EFI Systems
- $70 Boost Control For 23% More Grunt
- All About Engine Management
- Modifying Engine Management Systems
- Water/Air Intercooling
- How To Use A Multimeter
- Wiring An Engine Transplant
- And Much More including some Awesome Engines!

AVAILABLE DIRECT FROM SILICON CHIP PUBLICATIONS
PO BOX 139, COLLAROY NSW 2097 - $8.95 Inc P&P
To order your copy, call (02) 9979 5644 9-5 Mon-Fri with your credit card details!

FROM THE PUBLISHERS OF "SILICON CHIP"

Here's how to insure your investment in SILICON CHIP

Are your SILICON CHIP copies getting damaged or dog-eared just lying around in a cupboard or on a shelf?
Can you find that particular issue you need to refer to?

Keep your copies safe, secure and always available with SILICON CHIP binders: they're cheap insurance!

- ✓ Easy to use
- ✓ Economical
- ✓ Each binder holds up to 14 issues, so you can also bind in those catalogs you're always losing, as well . . .
- ✓ And they look good, too!

Order by phone or fax from SILICON CHIP - or use the handy order form in this issue

It's 11pm: you need the pin-out of a 555 . . .

Or perhaps data on a popular transistor, regulator, LED or op-amp. Maybe the pin-outs of 4000 or 7400 series ICs.
Where are you going to find the data?

Go straight to your SILICON CHIP/Jaycar Giant Data Wallchart. There's information on selecting the right heatsink, testing transistors, wiring regulators. Plus capacitor marking codes, resistor colour codes, loads of computer information from RAM and EPROMs to ASCII codes and computer port pin-outs . . . Even common audio connector standards! All this in a glossy, coated poster perfect for hanging in your workshop or study!

- **HUGE 850 x 580mm**
- **Varnished for long life**
- **Heavy duty stock**
- **Colour-coded too!**

Order direct from SILICON CHIP: Phone (02) 9979 5644; Fax (02) 9979 6503
Unfolded in mailing tube: $9.95 (incl. p&p); or folded $5.95 (incl. p&p)